

# RF Toolbox

Version 4.0.0

August 9, 2012

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

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

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

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.
- Resistor Calculator - Calculate Required Series/Parallel Combinations
- Resistor Color Code Calculator - Determine the color code for a resistor
- Thermal Noise Calculator
- Pi Network Attenuator Calculator
- Tee Network Attenuator Calculator
- 555 Timer Oscillator Calculator
- RF Link Budget Calculator
- Skin Depth Calculator
- Gamma Match Calculator

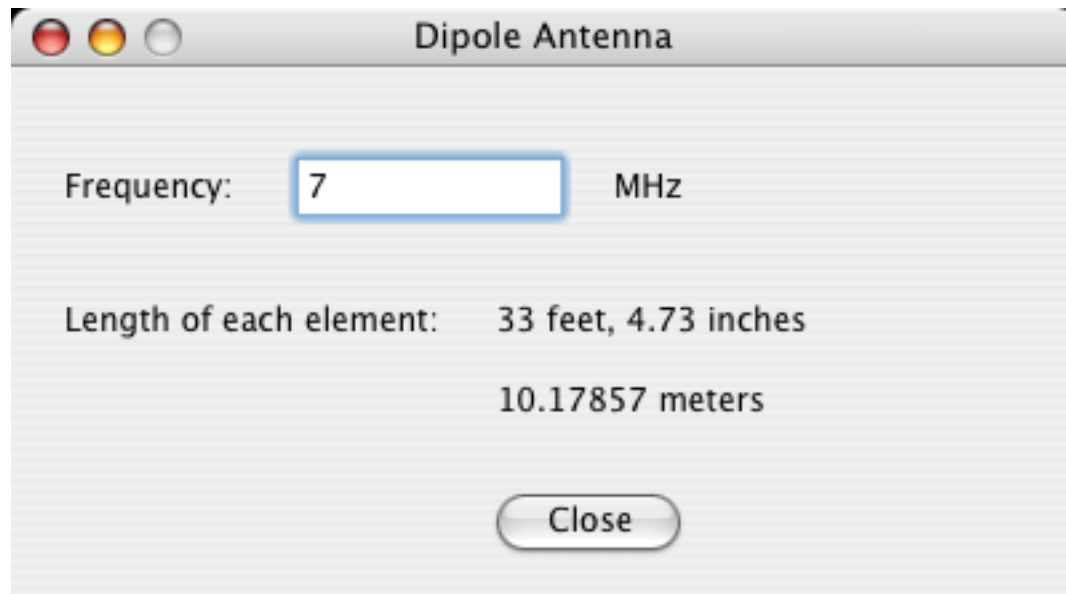
Use:

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

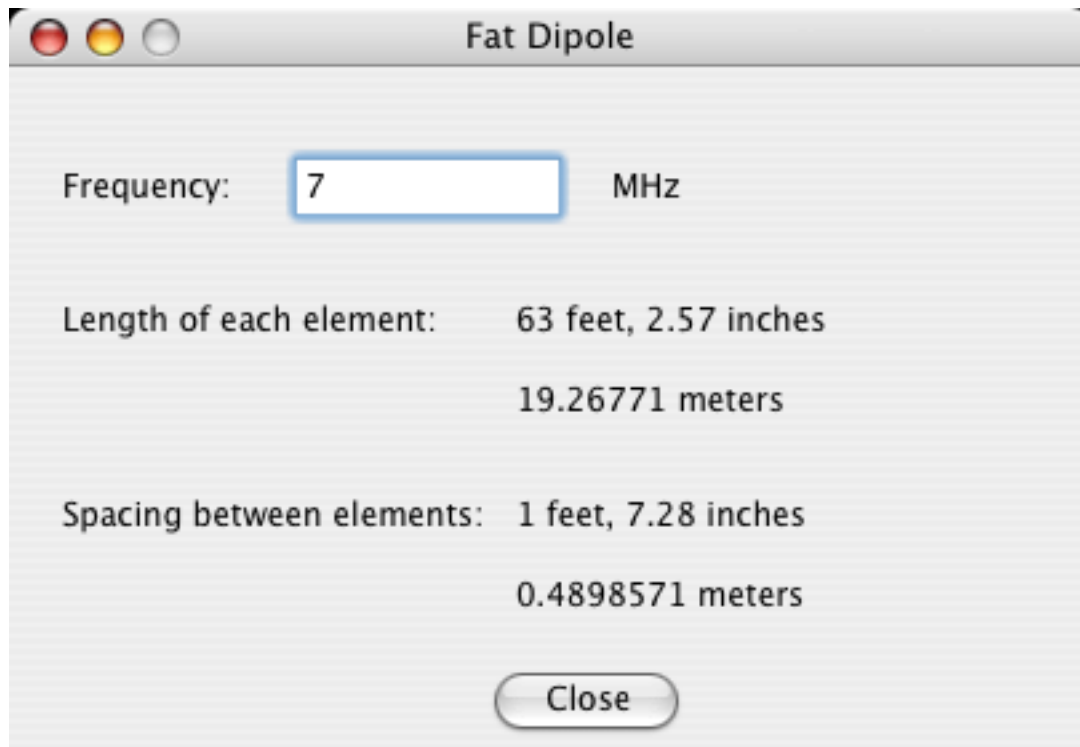


A screenshot of a software window titled "Dipole Antenna". The window has a standard macOS-style title bar with three colored buttons (red, yellow, grey) on the left. Inside the window, there is a label "Frequency:" followed by a text input field containing the number "7", and then the unit "MHz". Below 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



The image shows a screenshot of a software window titled "Fat Dipole". 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 text input field for "Frequency:" containing the number "7", followed by the unit "MHz". Below this, the results are displayed in two sections. The first section is for "Length of each element:", showing "63 feet, 2.57 inches" and "19.26771 meters". The second section is for "Spacing between elements:", showing "1 feet, 7.28 inches" and "0.4898571 meters". At the bottom center of the window is a rounded 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.

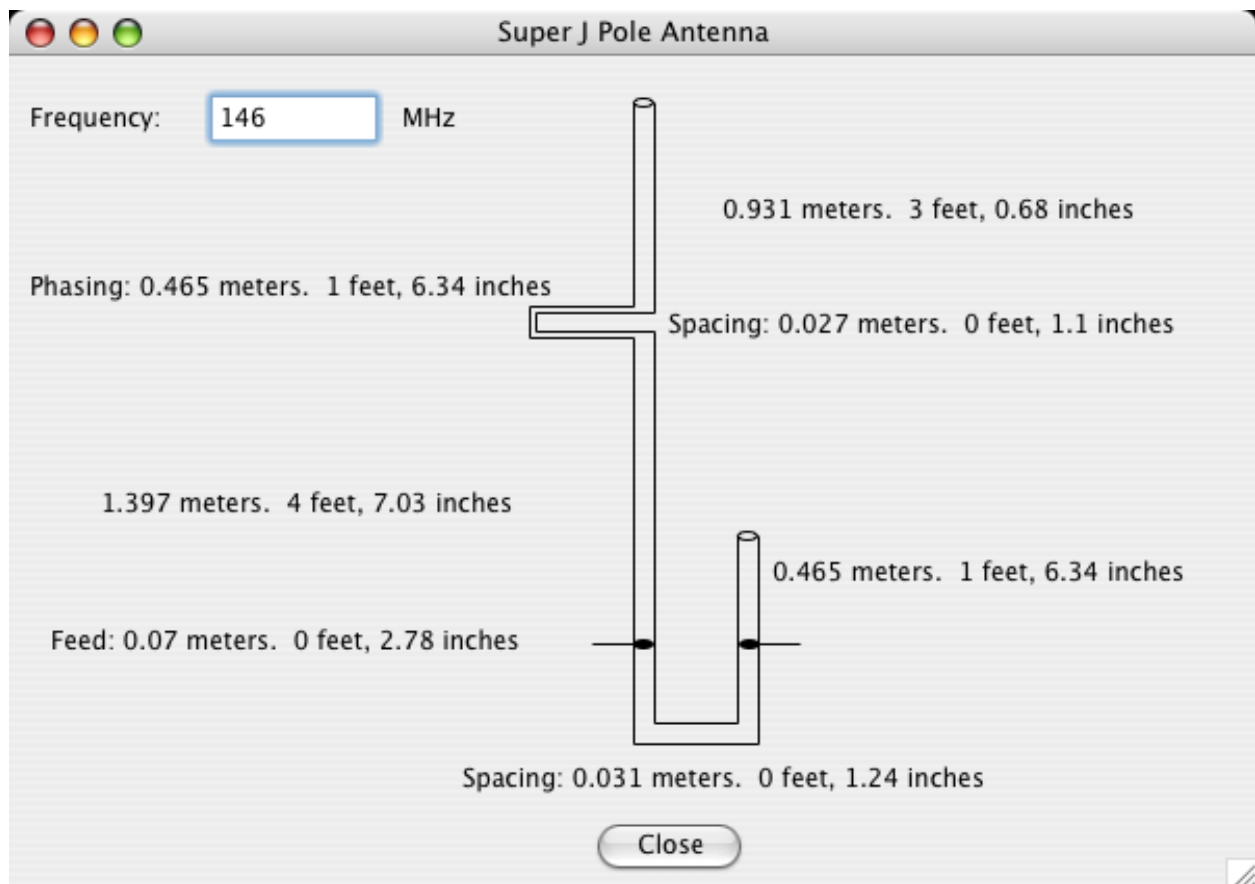
## J Pole Antenna Calculator

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". To the right of the input field is a diagram of a J-pole antenna, which consists of a vertical mast, a horizontal base, and a shorter vertical whip. Dimensions are labeled next to the diagram: the mast height is "1.397 meters. 4 feet, 7.03 inches", the whip height is "0.465 meters. 1 feet, 6.34 inches", the feed line length is "Feed: 0.07 meters. 0 feet, 2.78 inches", and the spacing between the mast and whip is "Spacing: 0.089 meters. 0 feet, 3.52 inches". At the bottom of the window is a "Close" button.

Component	Value (meters)	Value (feet, inches)
Mast Height	1.397	4 feet, 7.03 inches
Whip Height	0.465	1 feet, 6.34 inches
Feed Length	0.07	0 feet, 2.78 inches
Spacing	0.089	0 feet, 3.52 inches

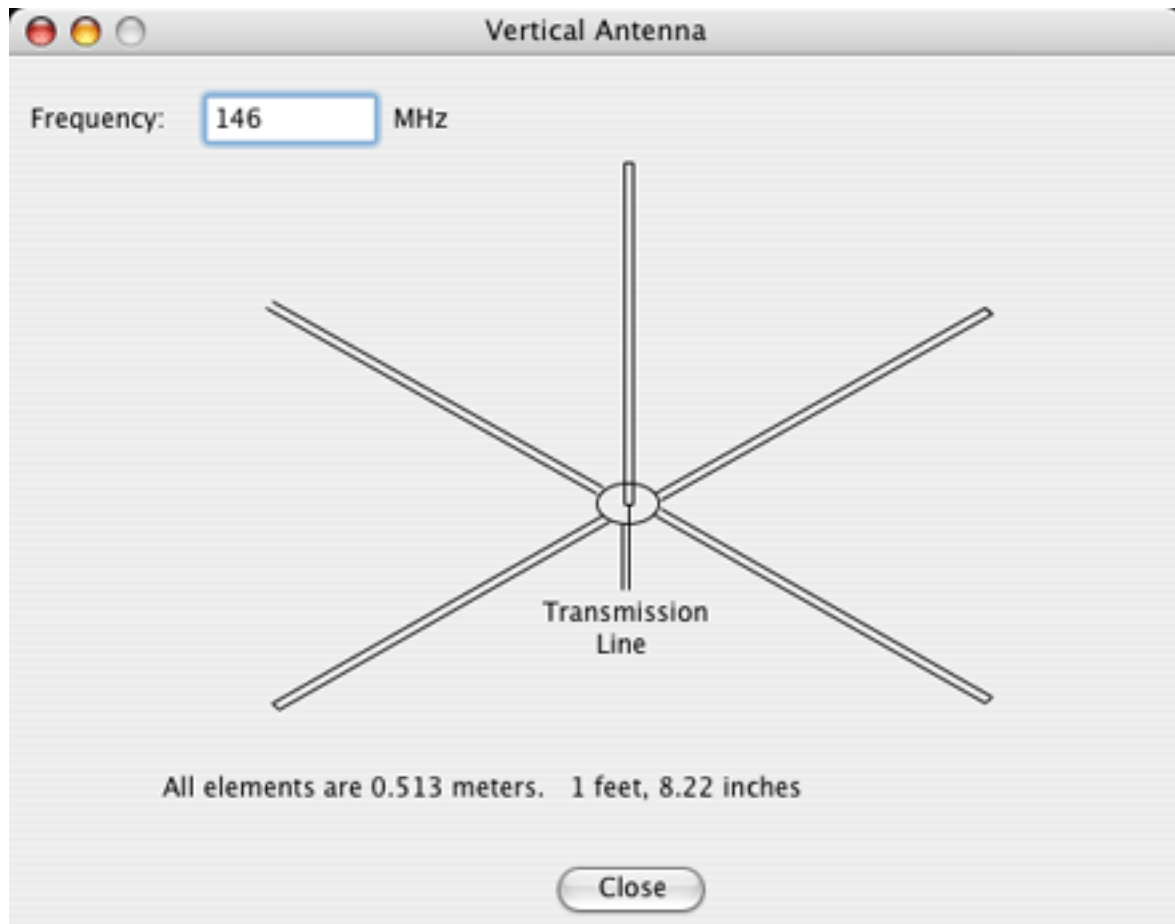
Enter in the desired operating frequency in MHz. The dimensions for the antenna elements are calculated and displayed.

## Super J Pole Antenna Calculator



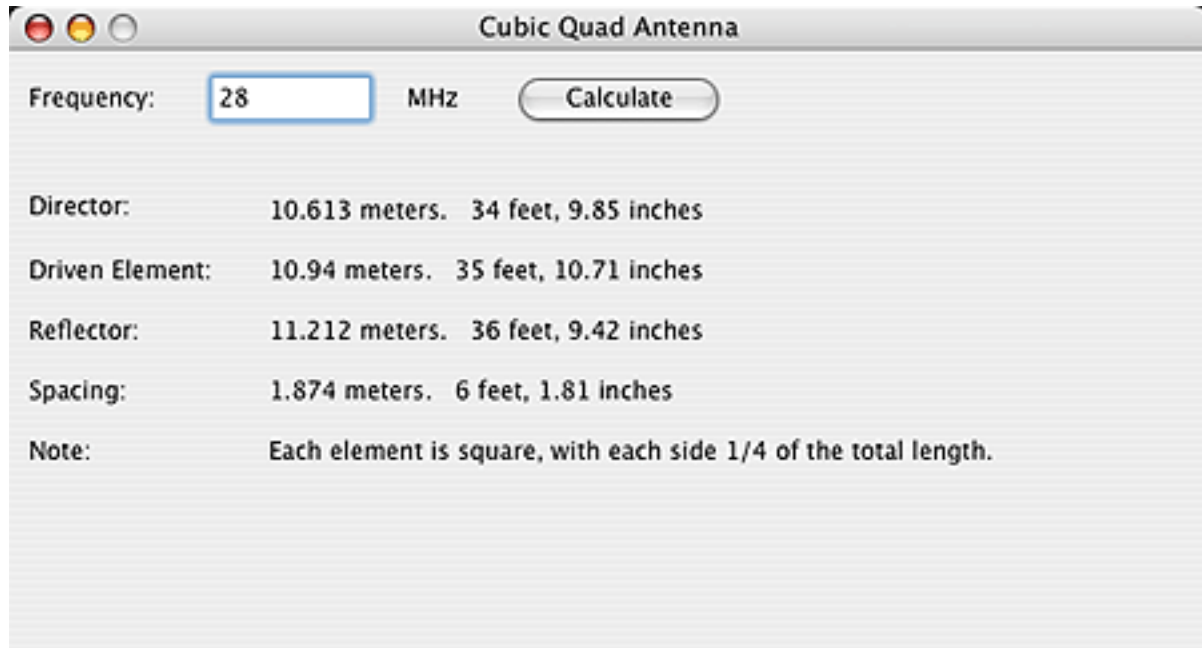
Enter in the desired operating frequency in MHz. The dimensions for the antenna elements are calculated and displayed.

## 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". To the right of the input field is the unit "MHz". Further right is a "Calculate" button. Below these controls, the results of the calculation 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 standard macOS window control buttons (red, yellow, and gray). Below the title bar, the "Frequency:" label is followed by a text input field containing "146", then the unit "MHz". To the right, the "Elements:" label is followed by a spinner control showing the number "6". A rounded "Calculate" button is positioned to the right of the spinner. Below these controls, the calculated dimensions and spacings for the antenna elements are listed. Each element type is preceded by a black horizontal bar representing its length. The elements are: four Directors, one Driven Element, and one Reflector. Each entry shows its length in meters and feet/inches, and the spacing between elements 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		

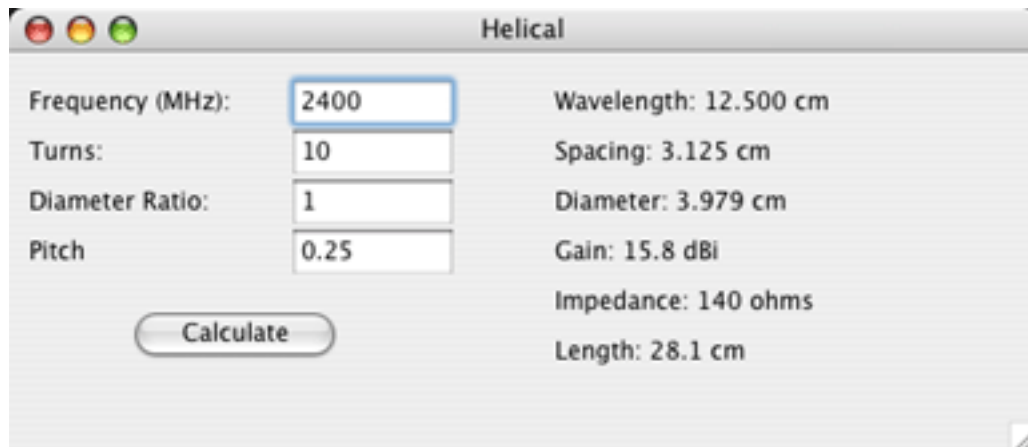
Enter in the desired operating frequency in MHz. The dimensions and spacings for the antenna elements are calculated and displayed.

## 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". The "Frequency (MHz)" field is highlighted with a blue border and contains the value "2400". The "Turns" field contains "10", "Diameter Ratio" contains "1", and "Pitch" contains "0.25". Below these fields is a "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 fields and values:

- 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: A slider bar labeled 'Modulo 1/2 Wavelength' is positioned at approximately 0.4602 wavelengths, with a phase angle of 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

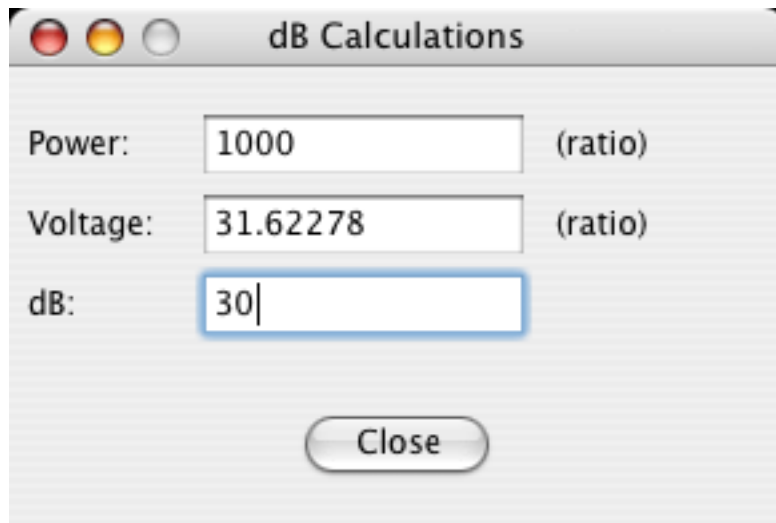
SWR: 1.46    Attenuation due to SWR: 0.024 dB    Total Loss: 0.4 dB

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



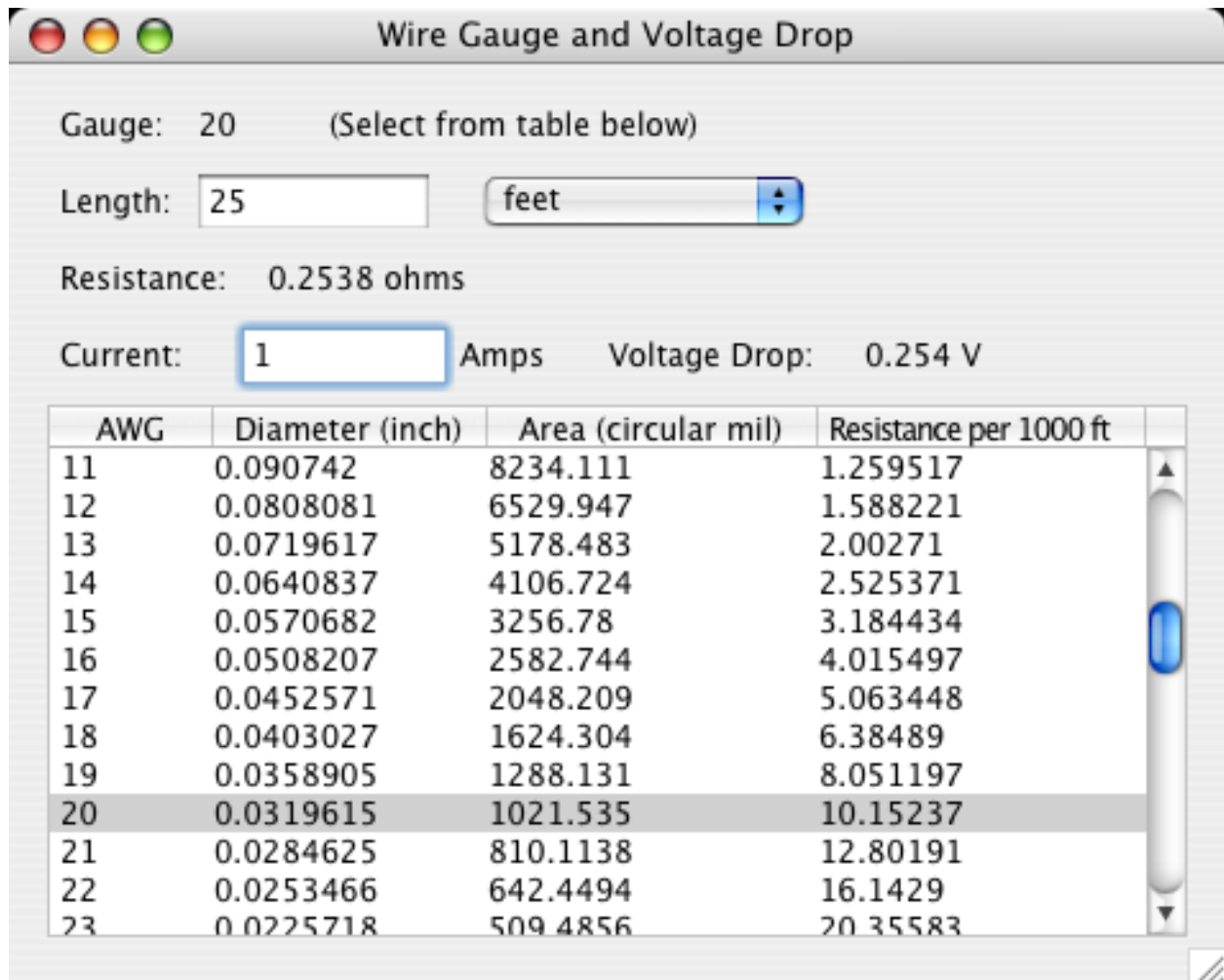
A screenshot of a macOS-style window titled "dB Calculations". The window has a title bar with three colored buttons (red, yellow, grey) on the left. Inside the window, there are three input fields arranged vertically. The first field is labeled "Power:" and contains the value "1000", with "(ratio)"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

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. Gauge 20 is highlighted. A scrollbar is visible on the right side of the table.

Gauge: 20 (Select from table below)

Length: 25 feet

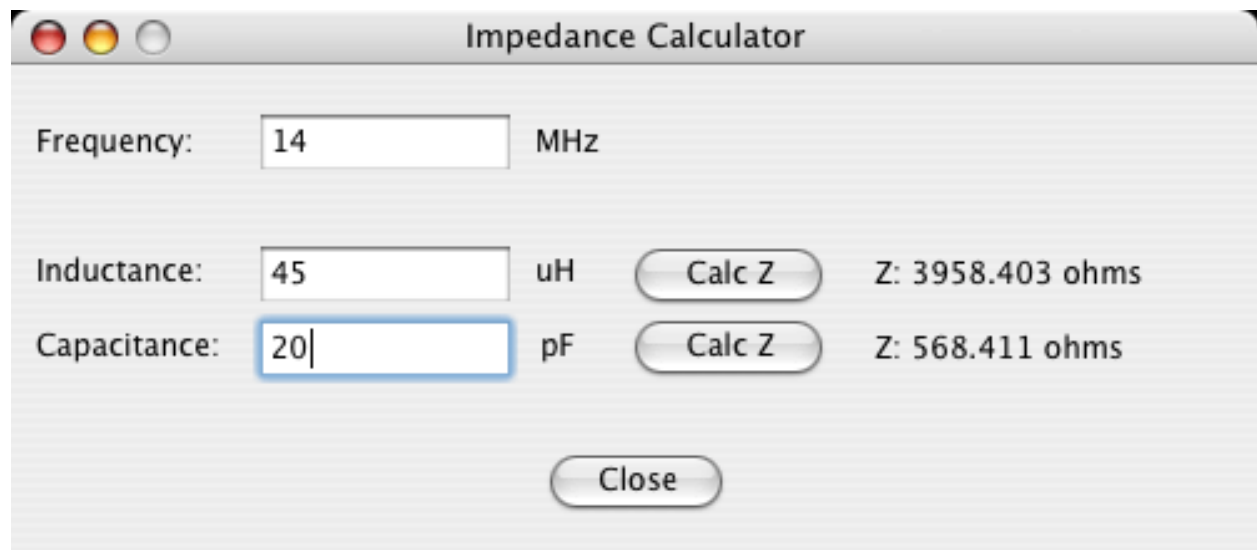
Resistance: 0.2538 ohms

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

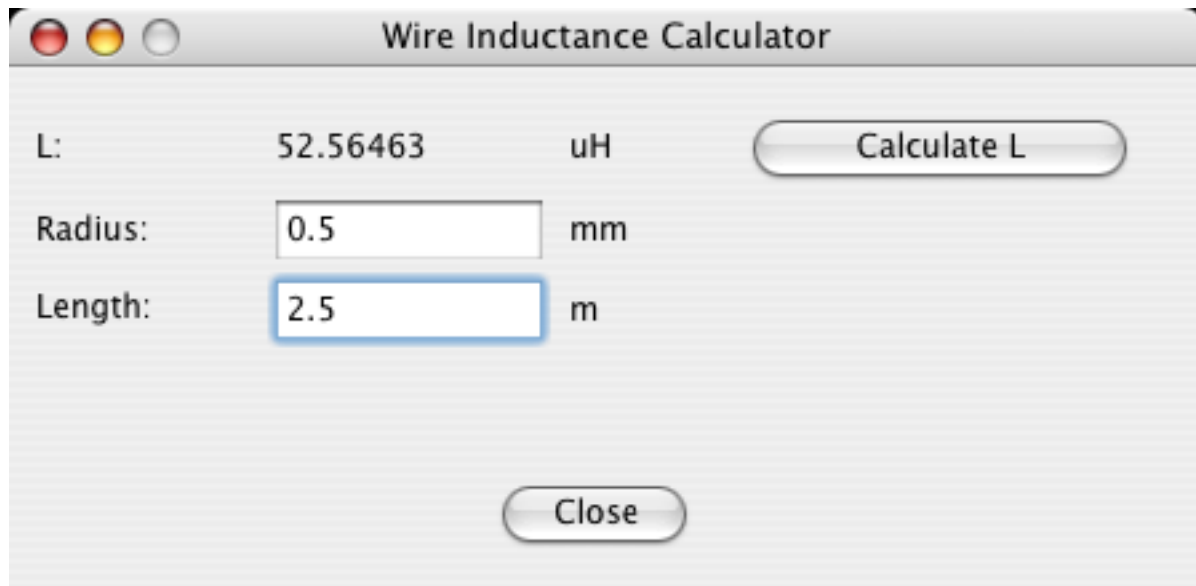


The image shows a software window titled "Impedance Calculator". It has a standard macOS-style title bar with three colored buttons (red, yellow, grey) on the left. The window contains three input fields: "Frequency:" with the value "14" and unit "MHz"; "Inductance:" with the value "45" and unit "uH"; 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". 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'.

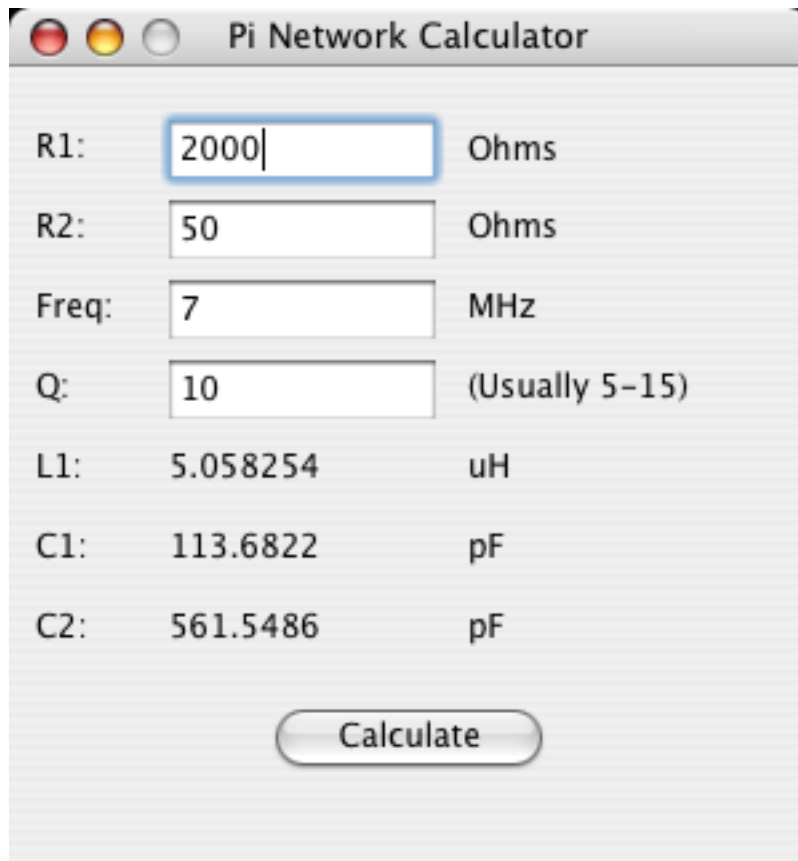
L:	52.56463	uH	Calculate L
Radius:	<input type="text" value="0.5"/>	mm	
Length:	<input type="text" value="2.5"/>	m	

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



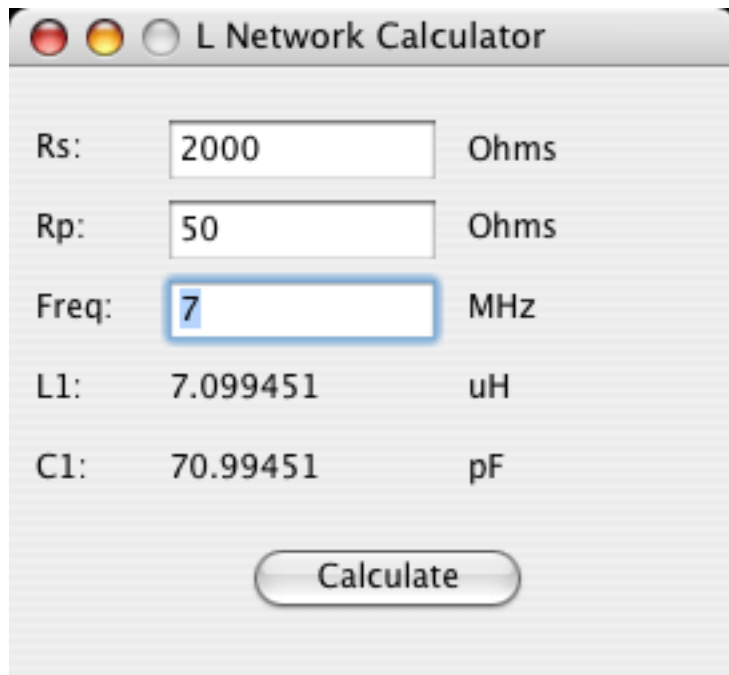
A screenshot of a software window titled "Pi Network Calculator". The window has a standard macOS-style title bar with red, yellow, and green window control buttons. Inside the window, there are input fields for R1, R2, Freq, and Q, and output fields for L1, C1, and C2. A "Calculate" button is at the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



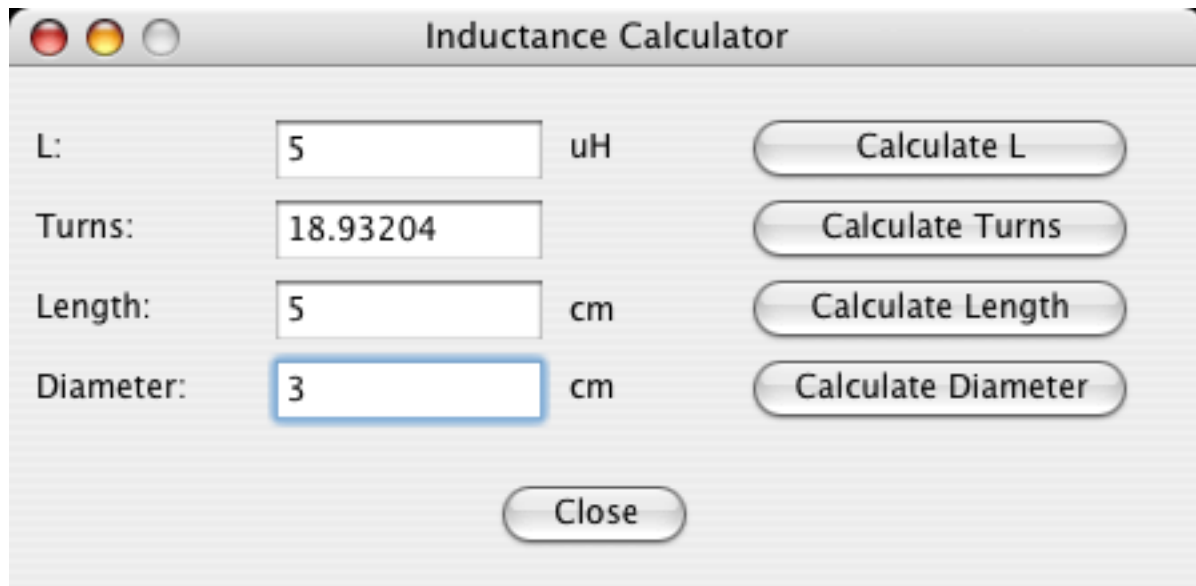
The screenshot shows a window titled "L Network Calculator" with a standard macOS-style title bar (red, yellow, and green buttons). The window contains five input fields and their corresponding units, followed by a "Calculate" button. The inputs are: Rs (2000 Ohms), Rp (50 Ohms), Freq (7 MHz), L1 (7.099451 uH), and C1 (70.99451 pF). The "Freq" field is currently selected with a blue highlight.

Parameter	Value	Unit
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



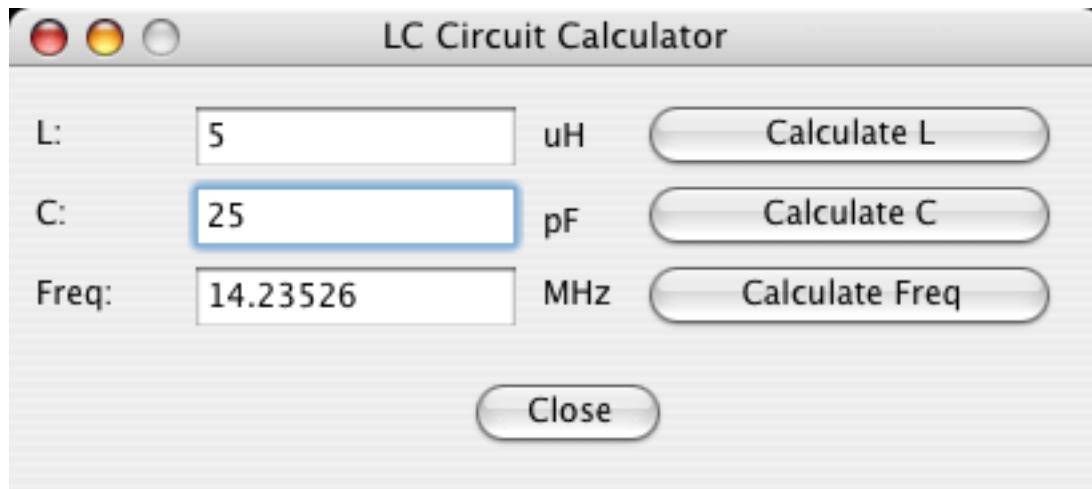
The image shows a graphical user interface for an "Inductance Calculator". The window has a title bar with standard macOS window controls (red, yellow, and grey buttons) and the title "Inductance Calculator". Inside the window, there are four rows of input fields and corresponding buttons:

Field	Value	Unit	Button
L:	5	uH	Calculate L
Turns:	18.93204		Calculate Turns
Length:	5	cm	Calculate Length
Diameter:	3	cm	Calculate Diameter

At the bottom center of the window is a "Close" button. The "Diameter" input field is currently selected with a blue border.

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



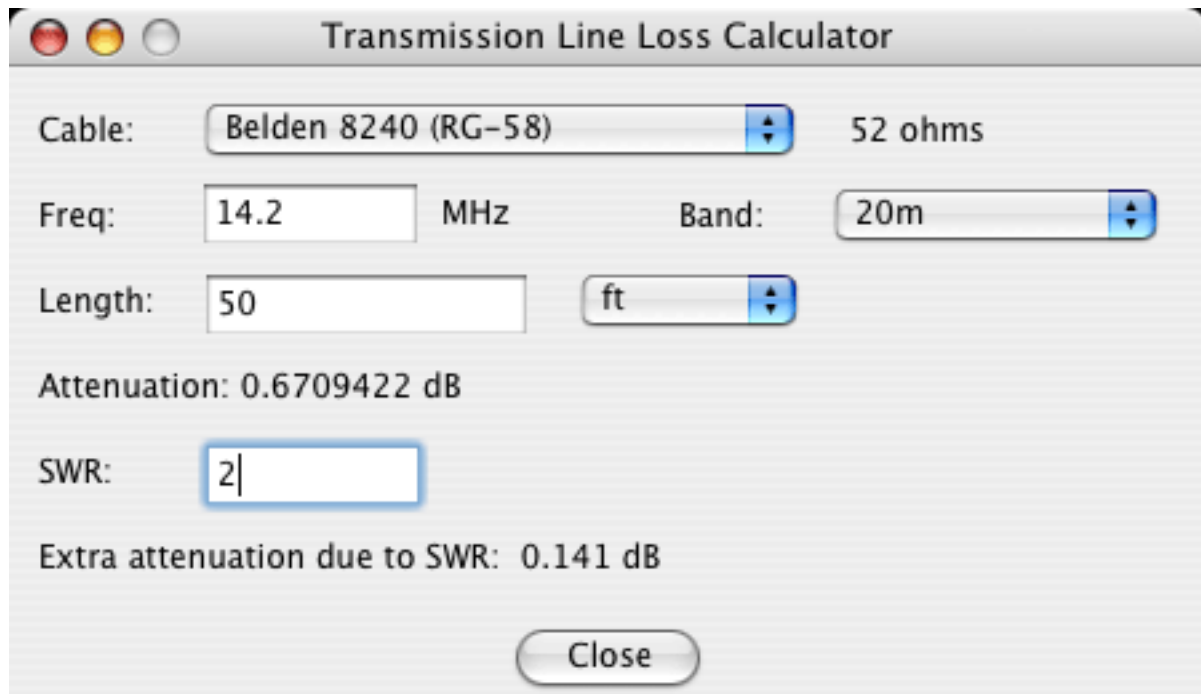
The image shows a window titled "LC Circuit Calculator" with a standard macOS-style title bar (red, yellow, and green buttons). The window contains three rows of input fields and buttons:

- Row 1: "L:" followed by a text box containing "5", the unit "uH", and a button labeled "Calculate L".
- Row 2: "C:" followed by a text box containing "25", the unit "pF", and a button labeled "Calculate C".
- Row 3: "Freq:" followed by a text box containing "14.23526", the unit "MHz", and a button labeled "Calculate Freq".

At the bottom center of the window is a button labeled "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 window titled "Transmission Line Loss Calculator". It contains several input fields and calculated results. The "Cable" field is a dropdown menu showing "Belden 8240 (RG-58)" with "52 ohms" to its right. The "Freq:" field has a text input "14.2" followed by "MHz". The "Band:" field is a dropdown menu showing "20m". The "Length:" field has a text input "50" followed by a unit dropdown menu showing "ft". Below these inputs, the "Attenuation:" is displayed as "0.6709422 dB". The "SWR:" field has a text input "2". Below that, the "Extra attenuation due to SWR:" is displayed as "0.141 dB". At the bottom center is a "Close" button.

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

**Close**

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.

## Resistor Color Code Calculator

Resistor Calculator

4 Band Code

4.7K

ohms

10%

tolerance

470 2

Y

V

R

S

E

I

E

I

L

O

D

L

L

L

V

O

E

E

W

T

R

5 Band Code

47000

tolerance

2%

Y

V

B

R

R

E

I

L

E

E

L

O

A

D

D

L

L

C

O

E

K

W

T

The resistor color code calculator allows you to determine the color code for both 4 and 5 band resistors. For 4 band resistors, select the resistance and tolerance from the popup menus. For 5 band resistors, type in the resistance in ohms, and select the tolerance from the popup menu.

The resistor color codes are displayed, along with the name of each color under the band, since some colors may be difficult to distinguish.

## Resistor Calculator

The resistor calculator allows you to perform four calculations:

1. Display the values for a resistor series.
2. Find the nearest resistor to a specified value.
3. Find the nearest series combination of resistors to a specified value.
4. Find the nearest parallel combination of resistors to a specified value.

For each of these, you can select which resistor series to use:

E6, E12, E24, E48, E96, and S192

Select the series to use by clicking on the series, multiple series can be selected.



## Butterworth and Chebyshev Low and High Pass Filter Design

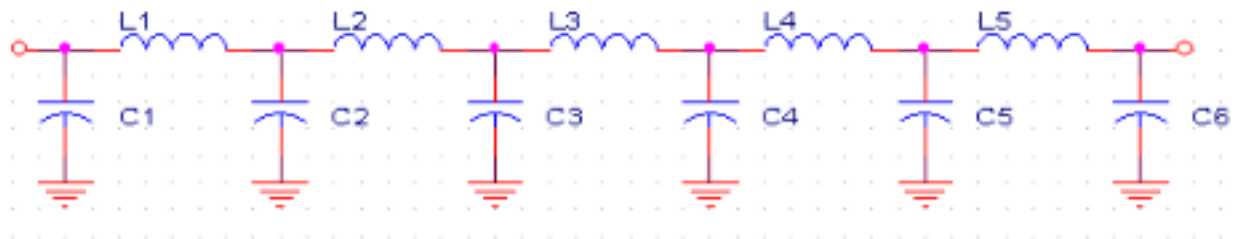
This window allows you to design a filter. You have two sets of choices, either low or high pass, and either Butterworth or Chebyshev.

A low pass filter attenuates frequencies above the cutoff frequency, while a high pass filter attenuates frequencies below the cutoff frequency.

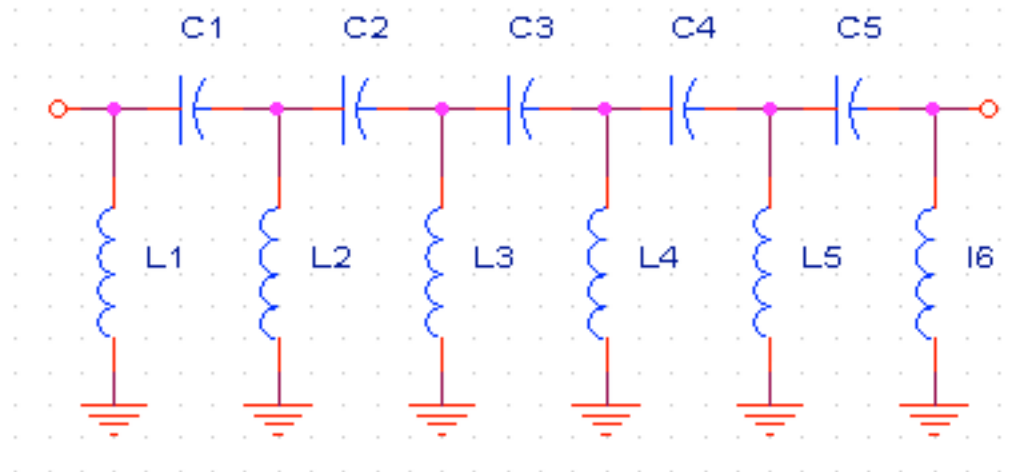
A Butterworth filter has a flat response in the passband and a constant 20 dB per decade attenuation for each pole of the circuit (equal to the order). The attenuation is -3 dB at the cutoff frequency.

A Chebyshev filter has a sharper rate of attenuation than a Butterworth filter, at the expense of ripple in the passband. You specify the amount of ripple allowed in the Ripple box, in dB. Chebyshev filters must have an odd order.

### Low Pass Filter:



### High Pass Filter:



Enter in the cutoff frequency, impedance, and number of components (order) of the filter, select the unit types and filter type, and click on the

Calculate button. The component values will be displayed. You can change the units for inductance and capacitance, and the values will adjust, accordingly.

## RF Link Budget Calculator

This window allows you to perform calculations related to an RF link. You can calculate the required transmitter power, gain margin, or maximum distance, based on two of these parameters as well the frequency, transmit and receive antenna gains, cable losses, and receiver sensitivity.

To use the calculator, select the units (miles or km) as well as which parameter you wish to calculate. Then enter in the other parameters, the calculation will update as you each each parameter.

## Skin Depth Calculator

Enter in the frequency in MHz, the Resistivity in micro-ohm per cm, and the Relative Permeability. Click Calculate, and the skin depth in both micrometers and microinches will be calculated.

At the bottom of the window is a table of Resistivity and Relative Permeability values for common metals.

## Gamma Match Calculator

This allows you to calculate the performance of a gamma match, which is typically used to transform the impedance of a yagi or other antenna to match the impedance of the transmission line connected to it.

The gamma match consists of a short rod which is parallel to the driven element. The length of the rod, as well as the spacing and relative diameters of the rod and driven element determine the impedance transformation. By entering in these dimensions, as well as the input impedance of the antenna, the input impedance of the gamma match can be determined.

The goal is to produce a gamma match input impedance with a real component equal to the characteristic impedance of the transmission line (typically 52 or 75 ohms). There will also be a reactive component, this is cancelled by putting a capacitor in series with the connection to the center conductor of the coax, RF ToolBox converts the impedance to a capacitance for the design frequency.

## Long Yagi Design

This window allows you to design long Yagi antennas, up to 99 elements, using the DL6WU formula.

Select whether you would like to use mm or inches for dimensions.

Enter in the frequency in MHz.

Select whether you want to specify the gain in dB, or the length of the antenna from the popup menu, then enter in that value.

Choose one of three boom types:

Metal with bonded (electrically attached) elements

Metal with insulated elements

Non metallic

Enter in the diameter of the boom as well as the driven and parasitic elements.

Click Calculate, and the element information will be generated and displayed. You can print the results, or save them to a MININECPro format file for analysis.