TOM ESSENPREIS — KB9ENS

MAGNETIC LOOP ANTENNA

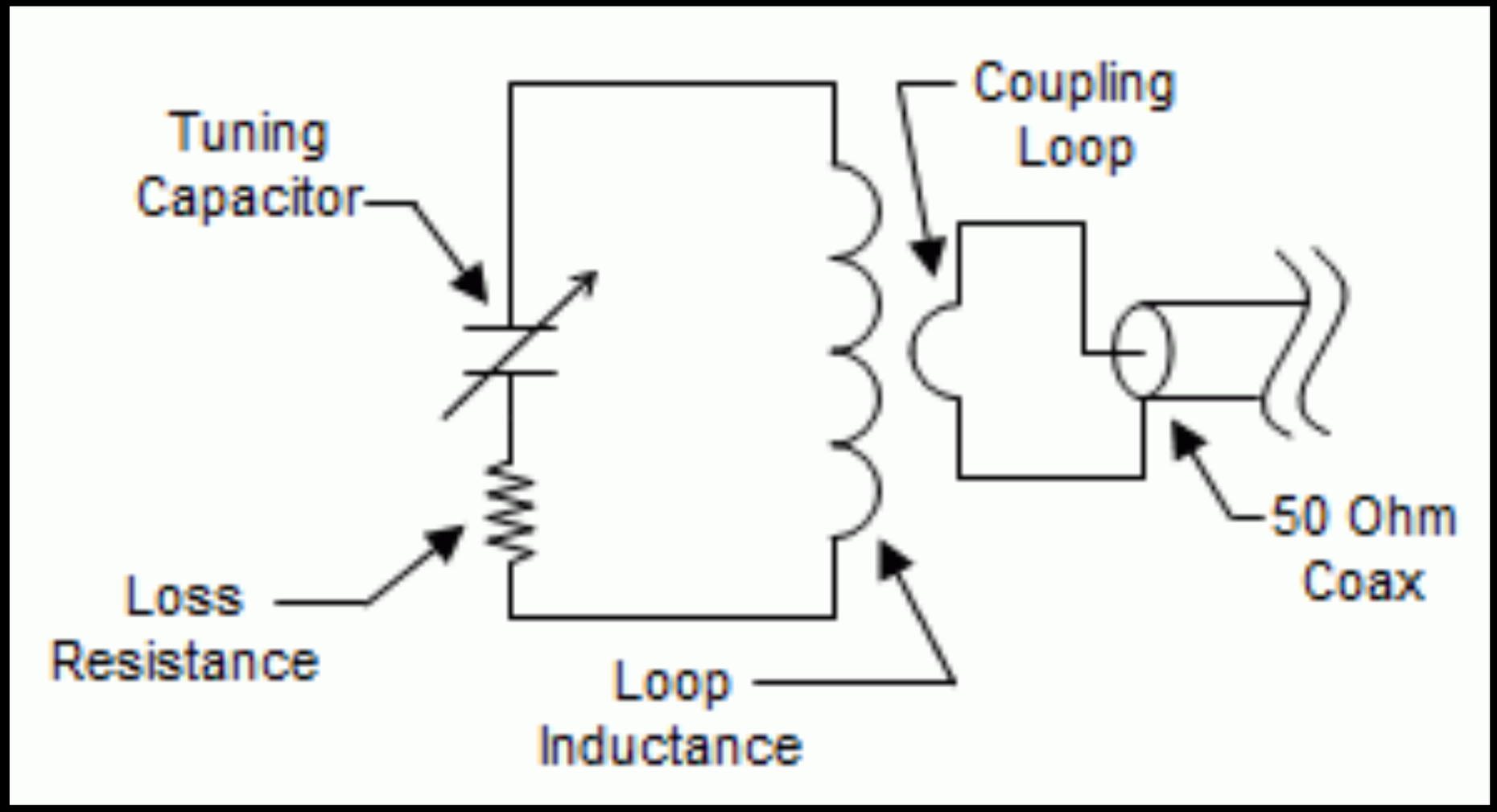
OVERVIEW

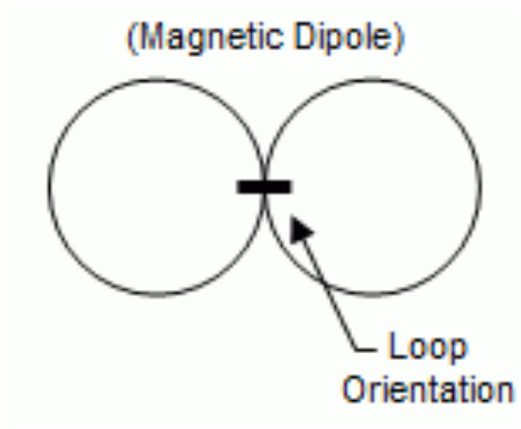
- Why?
- Circuit
- Calculator
- Hands On
- Demo

WHY?

- Acquisitions: (Pick two)
  - Cost/Schedule/Performance
- Antennas: (Pick two)
  - Small Size (relative to wavelength)
  - Efficiency
  - Broadband
- Noise rejection?

CIRCUIT:





Magnetic Loop Antenna Pattern

CALCULATOR

- ARRL Antenna manual
- AA5TB Calculator

Small Loop Equations for a Copper Loop

(circular loop assumed, results may vary with other shapes)

Radiation Resistance, Ohms: $R_R = (3.38\times10^{-8})(f^2A)^2$
Loss Resistance, Ohms: $R_L = (9.96\times10^{-4})(\sqrt{f})(S/d)$
Efficiency: $\eta = R_R/(R_R+R_L)$
Inductance, Henrys: $L = (1.9\times10^{-8})S[7.353\log_{10}(96S/\pi d)-6.386]$
Inductive Reactance, Ohms: $X_L = 2\pi f(L\times10^6)$
Tuning Capacitor, Farads: $C_T = 1/2\pi f(X_L\times10^6)$
Quality Factor: $Q = (f\times10^6)/\Delta f = X_L/2(R_R + R_L)$
Bandwidth, Hertz: $\Delta f = (f\times10^6)/Q = [(f_1-f_2)\times10^6]$
Distributed Capacity: pF: $C_D = 0.82S$
Capacitor Potential, Volts: $V_C = \sqrt{(PX_LQ)}$
Capacitor Voltage Rating: 75,000V/in

where

f = operating frequency, MHz
A = area of loop, square feet
S = conductor length, feet
d = conductor diameter, inches
η = decimal value; dB = $10\log_{10}\eta$
P = transmitter power, Watts

Small Magnetic Loop Antenna Calculator ver. 1.22a

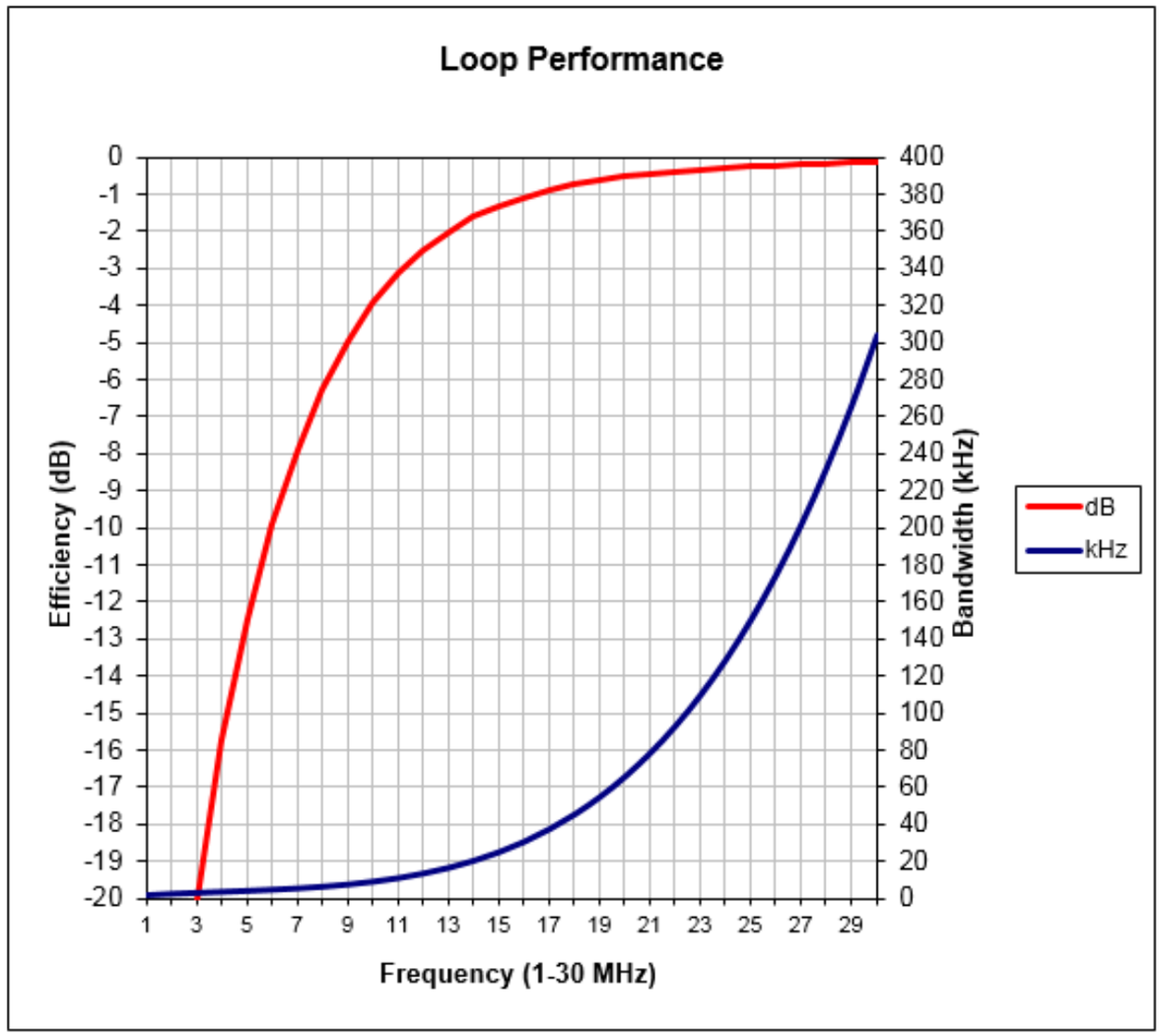
by Steve Yates
AA5TB
aa5tb@yahoo.com
Updated April 28, 2009

Input the following parameters:

Design Frequency =	**14.200** MHz	
Loop Diameter =	**3.500** feet	**1.067** m
Conductor Diameter =	**0.750** inches	**19.050** mm
Added Loss Resistance =	**0.000** milliohms	
RF Power =	**10.000** Watts	

Calculated Results:

Bandwidth =	**21.181** kHz (-3 dB points)	
Efficiency =	**69.806** %	**-1.561** dB
Loop Area =	**9.621** ft²	**0.894** m²
Radiation Resistance =	**127.210** mΩ	
Total Loss Resistance =	**55.025** mΩ	
Loop Circumference =	**10.996** ft	**3.351** m
Wavelength Percentage =	**15.874** % λ	
Loop Inductance =	**2.739** µH	
Distributed Capacitance =	**9.016** pF	
Q (Quality Factor) =	**670.412**	
Tuning Capacitor =	**45.870** pF	
Capacitor Voltage =	**1279.891** V	
Minimum Plate Spacing =	**17.065** mils (1/1000 in)	**0.433** mm



Notes:

1. To truly be considered a small loop, the **Loop Circumference** should be less then 10 % λ. Larger loops will have greater efficiency but smaller nulls.
2. To see the effects of bad joints, etc., input realistic values into the **Added Loss Resistance** box.
3. The sheets are protected to prevent the user that is unfamiliar with Excel from accidentally corrupting formulas. To unlock the sheets use the password **aa5tb**.
4. This application is free to use as you wish. If you modify it and pass it on all that I ask is that you give me credit for my part of the work. Thanks!

HANDS ON

- Volunteers:
  - Analyzer
  - Capacitor
- Exercise

1. Bound the performance
2. Tune a specific frequency
3. Attach transceiver and tune for sound
4. Test!

QUESTIONS