Rewards Await

… if You Are Willling !

Jeff - KØZR

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Some Facts About Circuit Design

- You don’t need to be an engineer to do this
- Designing your first circuit can be intimidating:
  - If it works – great
  - If it does not work – *not so* great!
    - However, you will learn far more from your mistakes than all your successes
- Many amateurs today are missing out on some of the greatest satisfaction amateur radio has to offer:
  - Designing and building something electronic
- It has never been easier with the wide variety of tools available on the internet today

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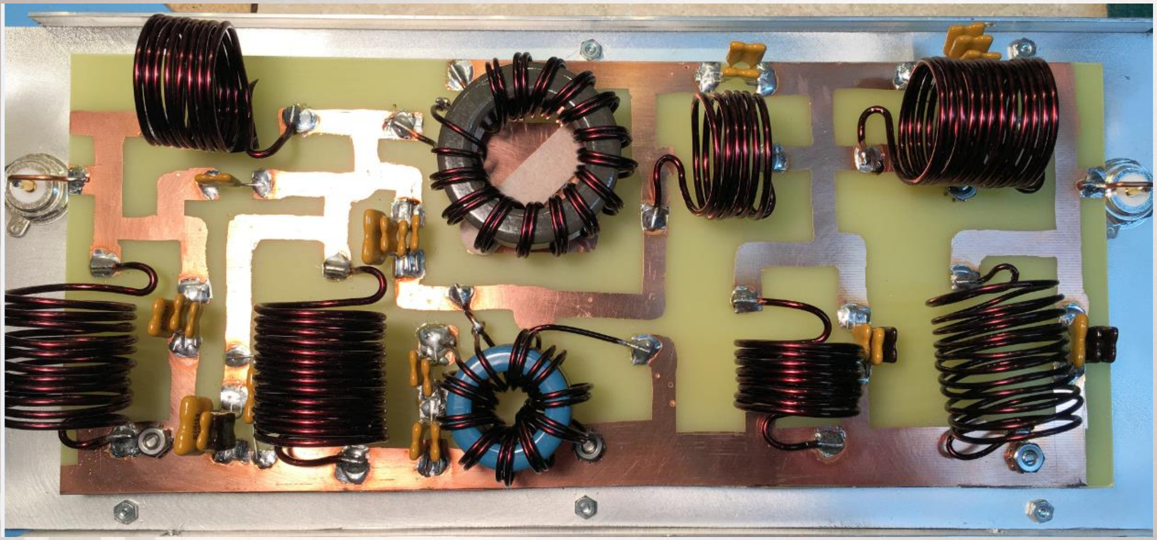
What Are Some of These Tools?

- For “true math” calculations, Python
  - Absolutely free: www.python.org
  - Beginner’s Guides found all over the internet
  - N1RM uses Python to post-process LARG Field Day data
  - W5ODJ uses Python to immediately provide azimuth headings for stations entered into his log
- L-network design for antenna matching
  - www.daycounter.com/Calculators/L-Matching-Network-Calculator
- Circuit analysis – “SPICE”
  - LT SPICE – from Linear Technology/Analog Devices
  - 5SPICE
  - PartSim
  - Simetrix - www.simetrix.com
    - This is what will be demonstrated today

KØZR 2 KW BPF for 80m

- Fall of 2016, I spoke about my homebrewed bandpass filters for SO2R



15” 15”

- Analysis revealed high RF current, requiring multiple, paralleled capacitors
  - Could have “painstakingly” used trial and error to determine combinations
  - Or could write a python “script” to optimally choose capacitor values from catalog values available

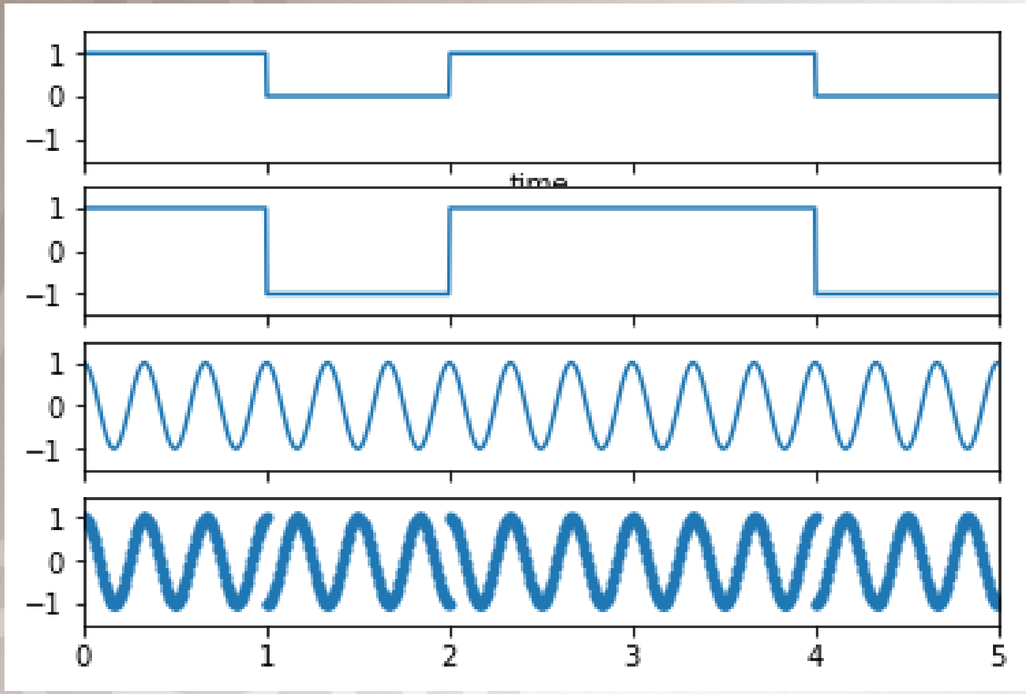
Python Example

- Wrote a python “script” which:
  - Chose capacitance values from standard catalog values and
    - Kept values somewhat close together to maintain optimal current sharing
    - Used a sufficient number of capacitors such that currents through each were kept below a specified maximum value

```
Enter Total Current, A: 12
Maximum Current in Each Capacitor, A:5
Enter Total Capacitance : 725
Requested Maximum Current Capacity = 12
>>> Minimum # of Capacitors to use is 3

 #    C1     #    C2    Cap Range   Tot Cap
 1  180.0    2  270.0     90.0       720.0
 1  200.0    2  270.0     70.0       740.0
 2  200.0    1  300.0    100.0       700.0
```

Simulate a BPSK Signal



- BPSK is one of the simplest digital formats – Binary Phase Shift Keying
- “1”s and “0”s are determined by the phase of the signal
- The downloaded version of Python I use has over 500 different libraries with literally thousands of functions at your fingertips

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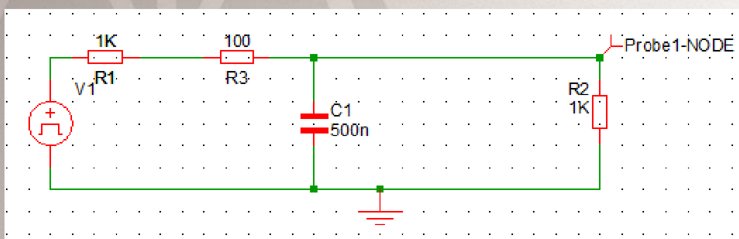
What is SPICE?

- SPICE stands for "Simulation Program with Integrated Circuit Emphasis"
  - First release was in 1973
  - Developed at University of California at Berkeley
  - Many versions and improvements since then
    - Most visible improvements are standard Windows interfaces, etc
- With SPICE one can design passive circuits, such as matching networks, multiple-transistor amplifiers, or digital logic
  - Most SPICE versions have catalogs of parts "built-in", thus accelerating the development of designs

Why Simetrix?

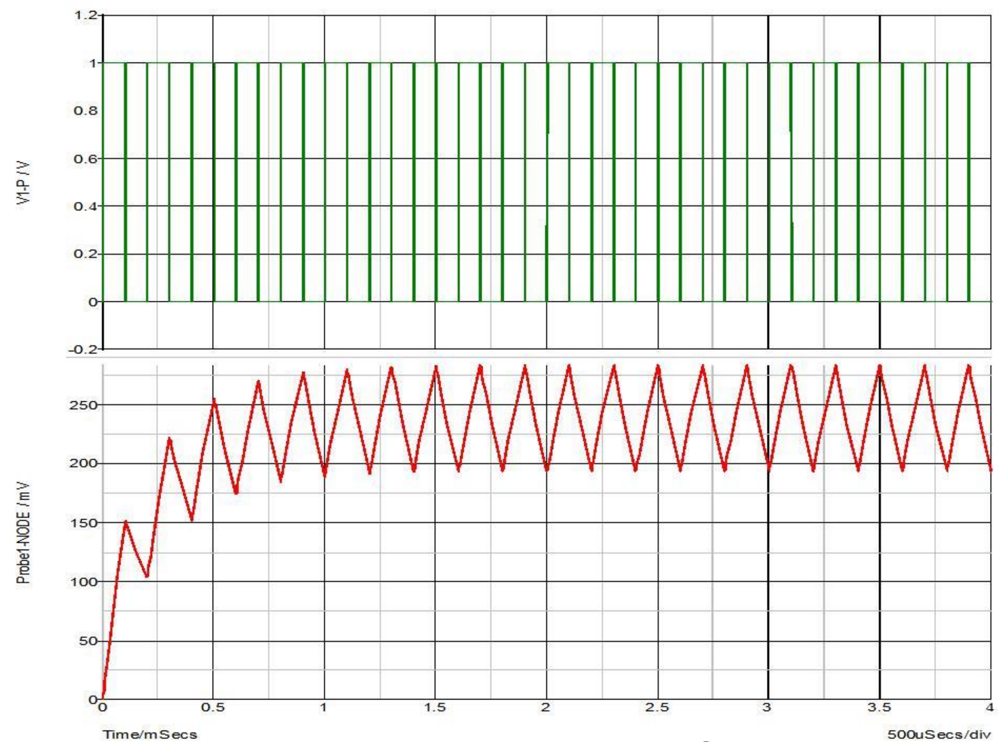
- Of the SPICE programs mentioned earlier, Simetrix was selected here largely because this is what I use in my work environment
  - My version costs in excess of $10,000
    - Unlimited nodes and circuit elements
    - Exhaustive component libraries
  - The free version is limited to ~ 100 elements
    - Generally exceeds most people’s needs for amateur use
- I have used LTSpice and 5SPICE but they are generally not used in the professional engineering environments….

Circuit One: A Simple RC Circuit



A square-wave generator
f = 10 kHz

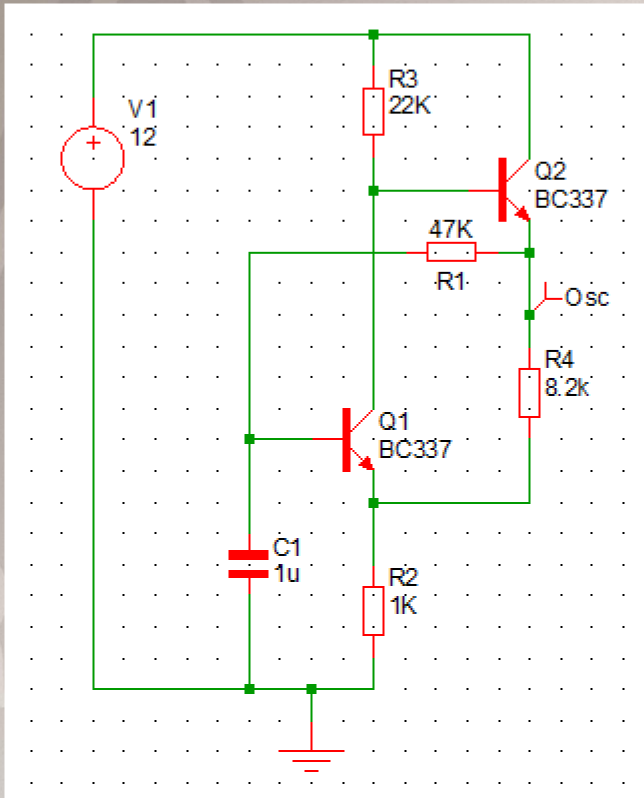
Input Signal

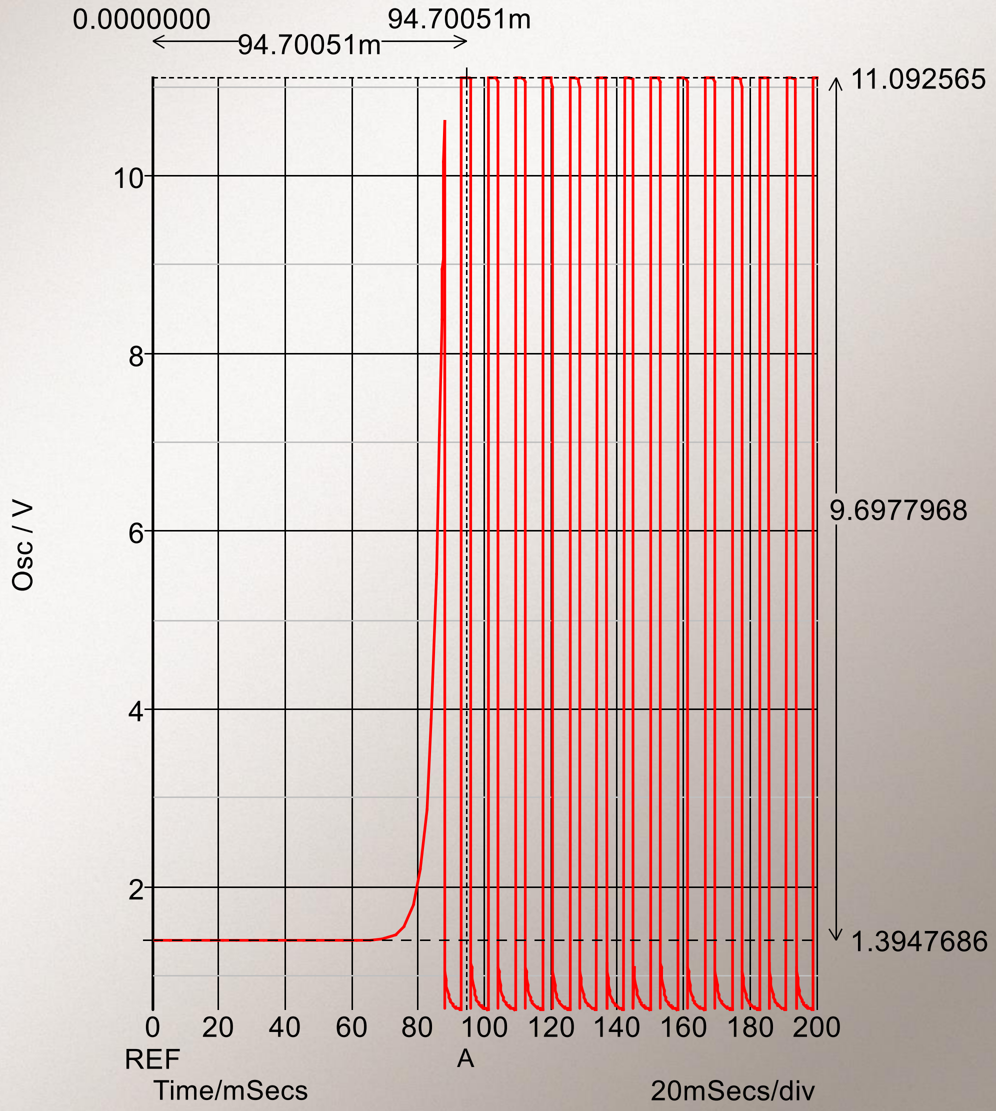


Output Waveform

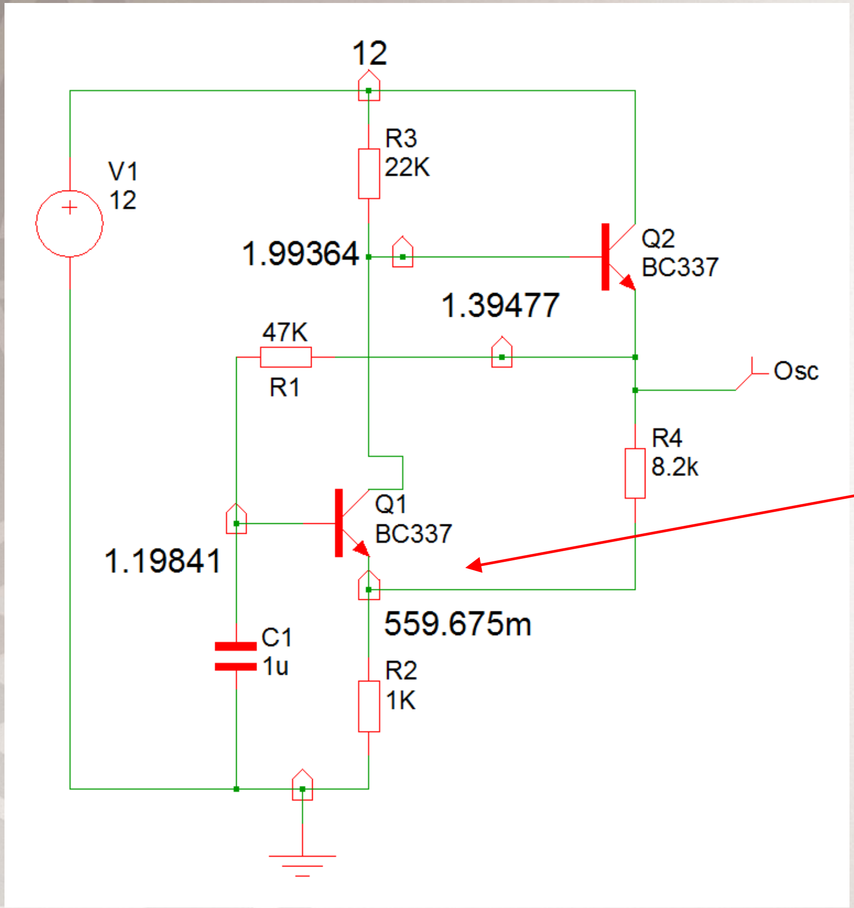
Each positive excursion of the square wave charges the capacitor more until it reaches the peak value, then it discharges until the next positive peak arrives

Two -Transistor Oscillator



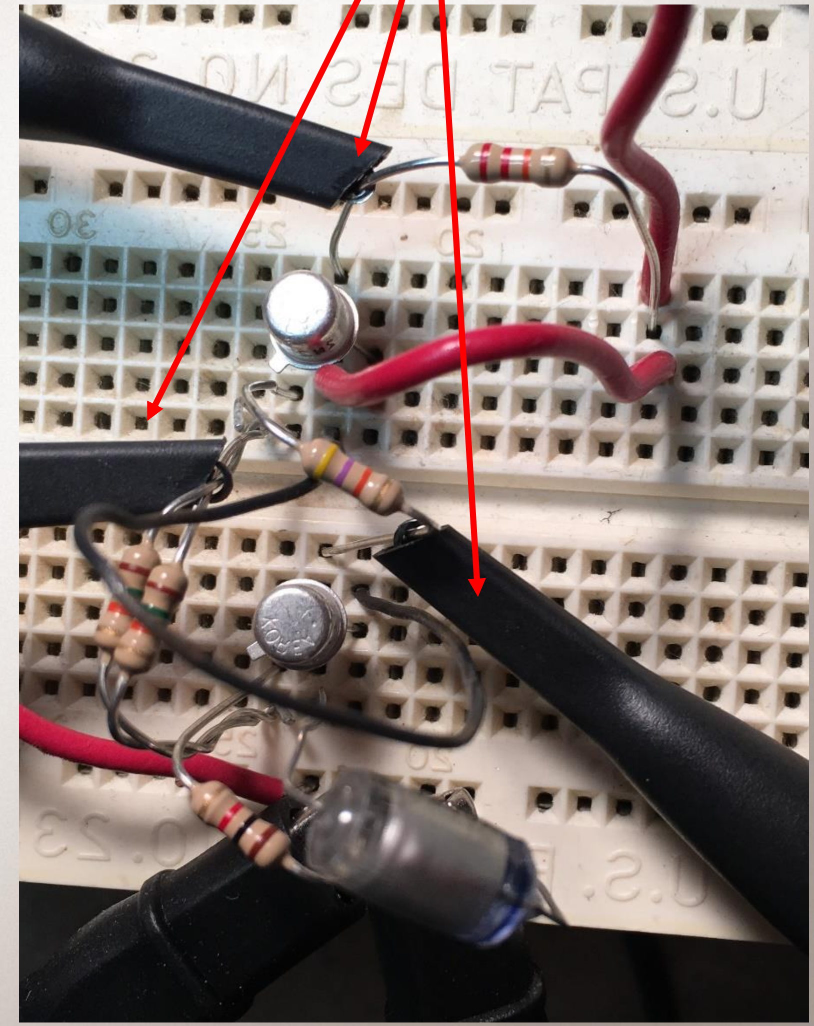


Bias Determination



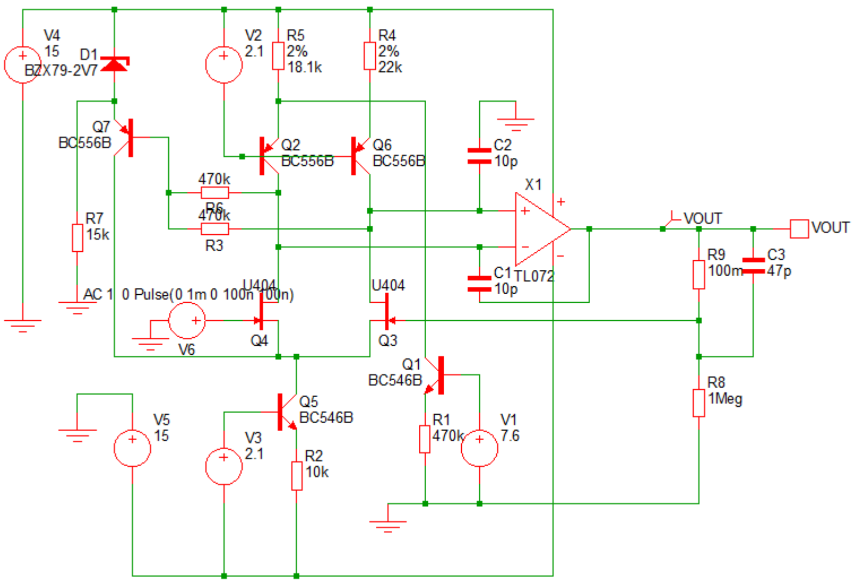
- Most SPICE programs will annotate the bias voltages and currents
  - Invaluable to troubleshooting
- Placing other "probes" allows determination of currents as well

Actual Breadboard – in 20 minutes

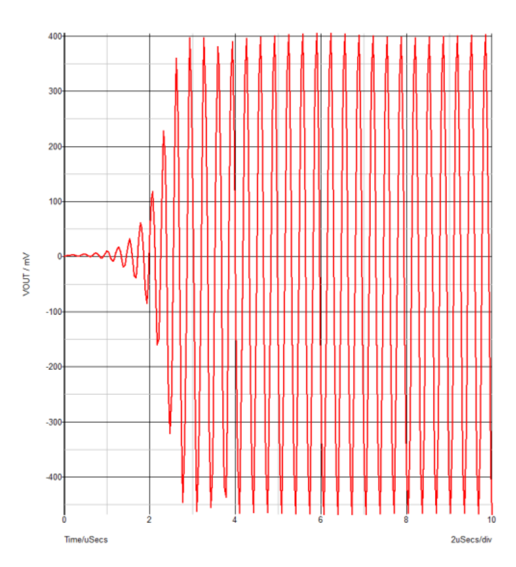


Yellow: Q_1 base
Blue: Q_2 emitter – Output
Magenta: Q_1 collector

Advanced Analyses - FFTs



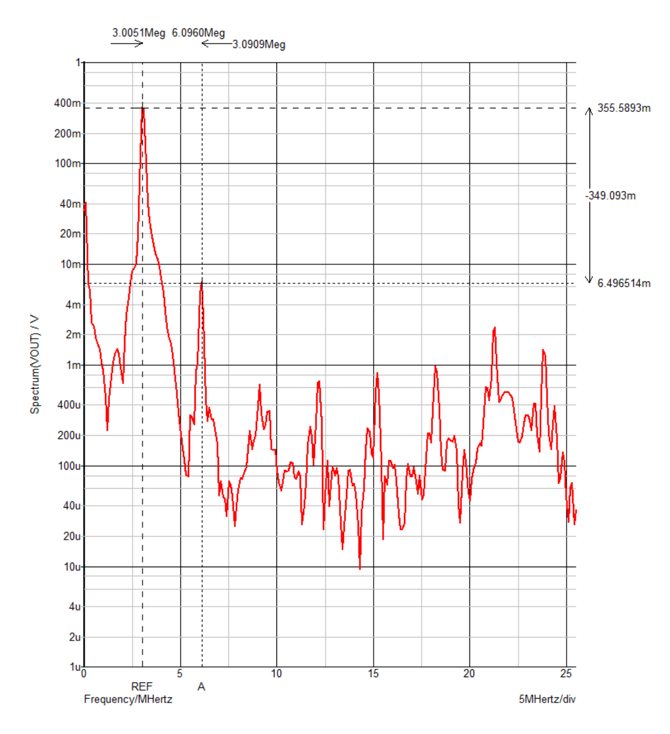
Precision FET amplifier. Circuit is unstable as it stands.
Increase C1 and C2 to stabilise
R8/R9 to control gain



Time Domain

Multi-Stage amplifier with sinewave input

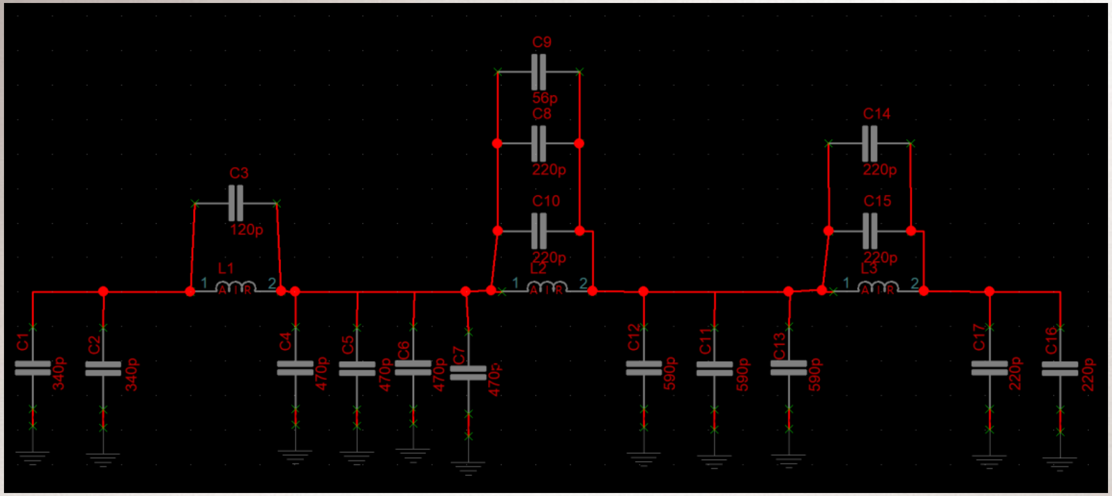
Frequency Domain



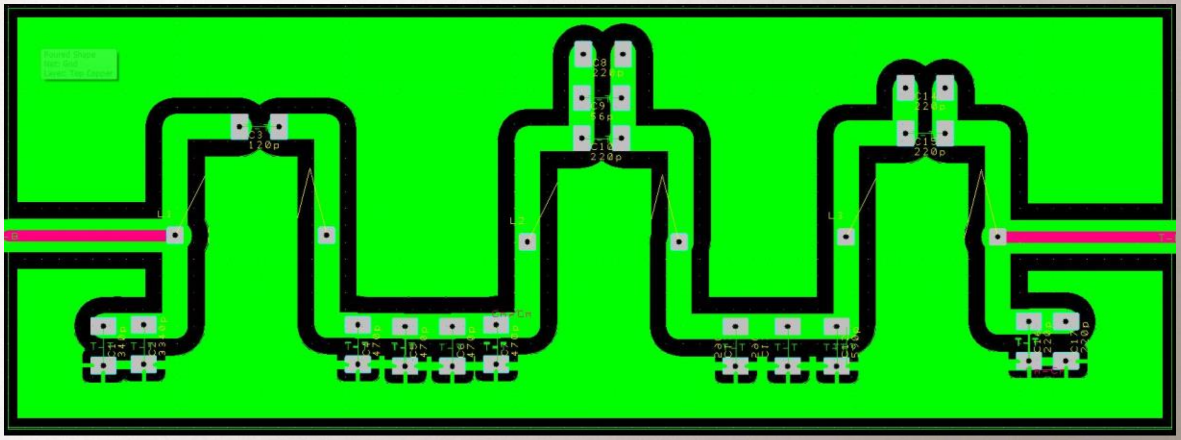
2nd harmonic down 80 dB

Design Sparc for PCB Layout

Lowpass Filter
for 160m



Microstrip Layout
of Filter



Putting EXCEL to Work

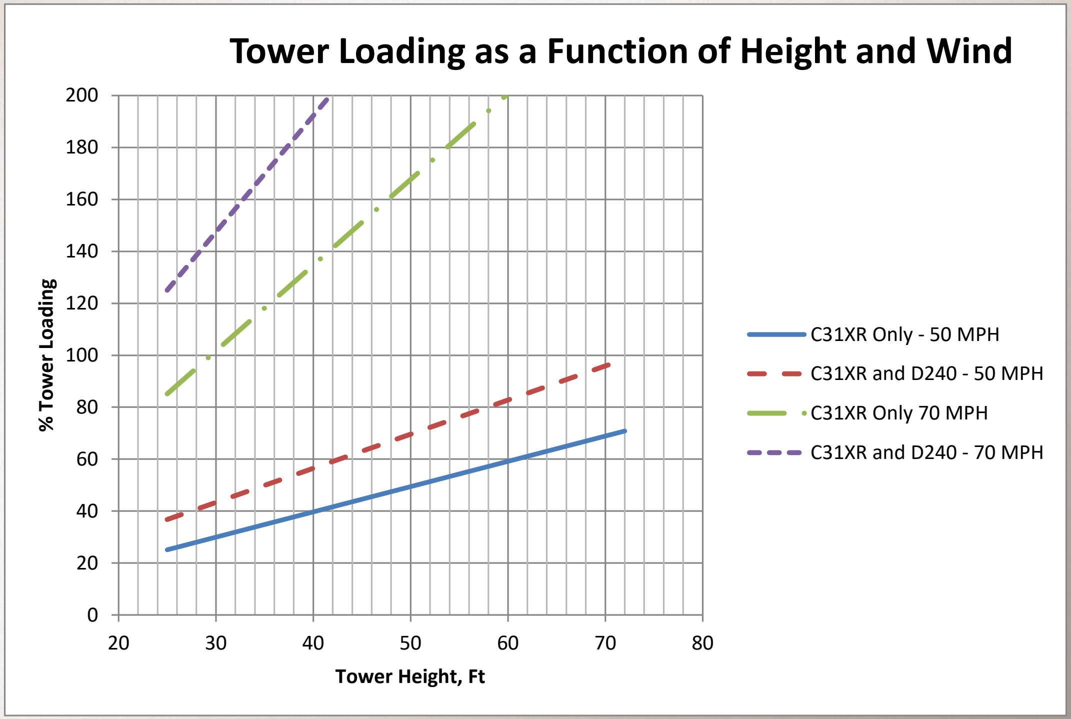
Formulae in ARRL Antenna Handbook allow for tower loading calculations – performed in Excel

C31XR ONLY - 50 MPH	
Tower Hgt	% Loading
25	25.1
30	29.96
35	34.83
40	39.69
45	44.56
50	49.42
55	54.29
60	59.15
65	64.02
70	68.88
72	70.83

C31XR & D-240- 50 MPH	
Tower Hgt	% Loading
25	36.72
30	43.29
35	49.87
40	56.44
45	63.02
50	69.59
55	76.16
60	82.74
65	89.31
70	95.89
72	98.52

C31XR ONLY - 70 MPH	
Tower Hgt	% Loading
25	85.1
30	101.61
35	118.12
40	134.64
45	151.15
50	167.66
55	184.18
60	200.69
65	217.21
70	233.72
72	240.32

C31XR & D-240- 70 MPH	
Tower Hgt	% Loading
25	125.03
30	147.41
35	169.8
40	192.19
45	214.57
50	236.96
55	259.34
60	281.73
65	304.12
70	326.5
72	335.46



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