Hacking Radiowaves For Fun

(But not Profit)

Craig Hills: W9CTH

Principal Software Engineer

FCC LICENSED
AMATEUR EXTRA CLASS RADIO OPERATOR

hacker

A person who delights in having an intimate understanding of the internal workings of a system, computers and computer networks in particular.

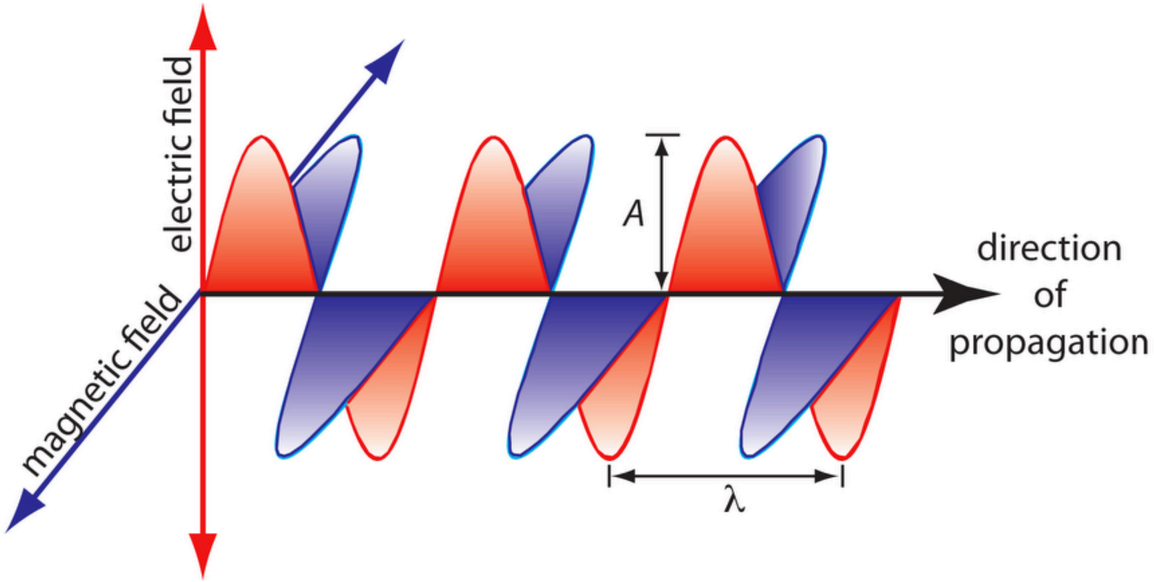
Goals

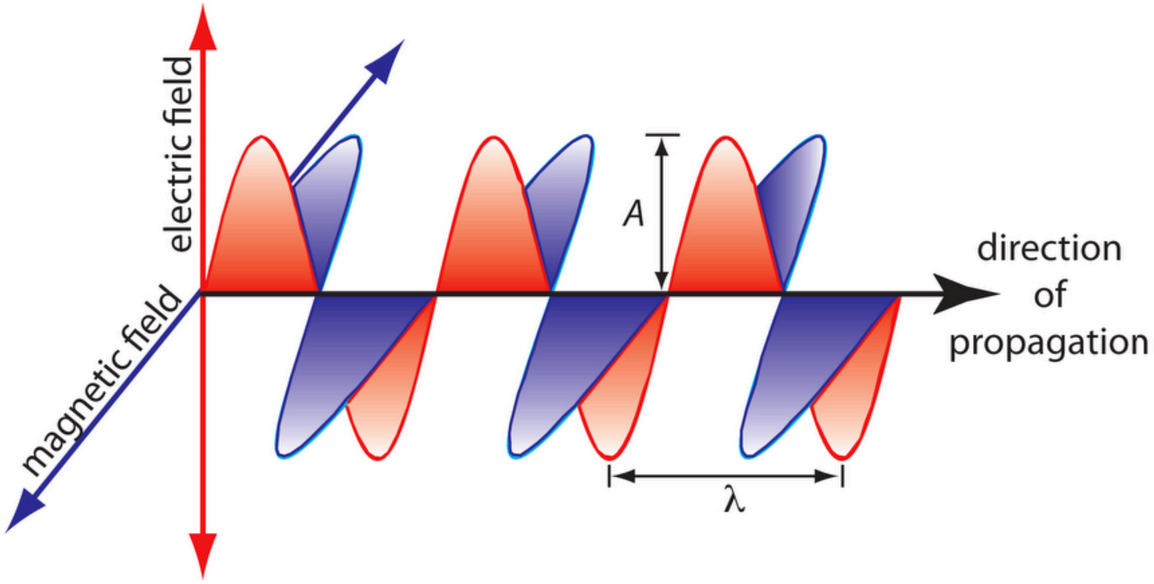
Background

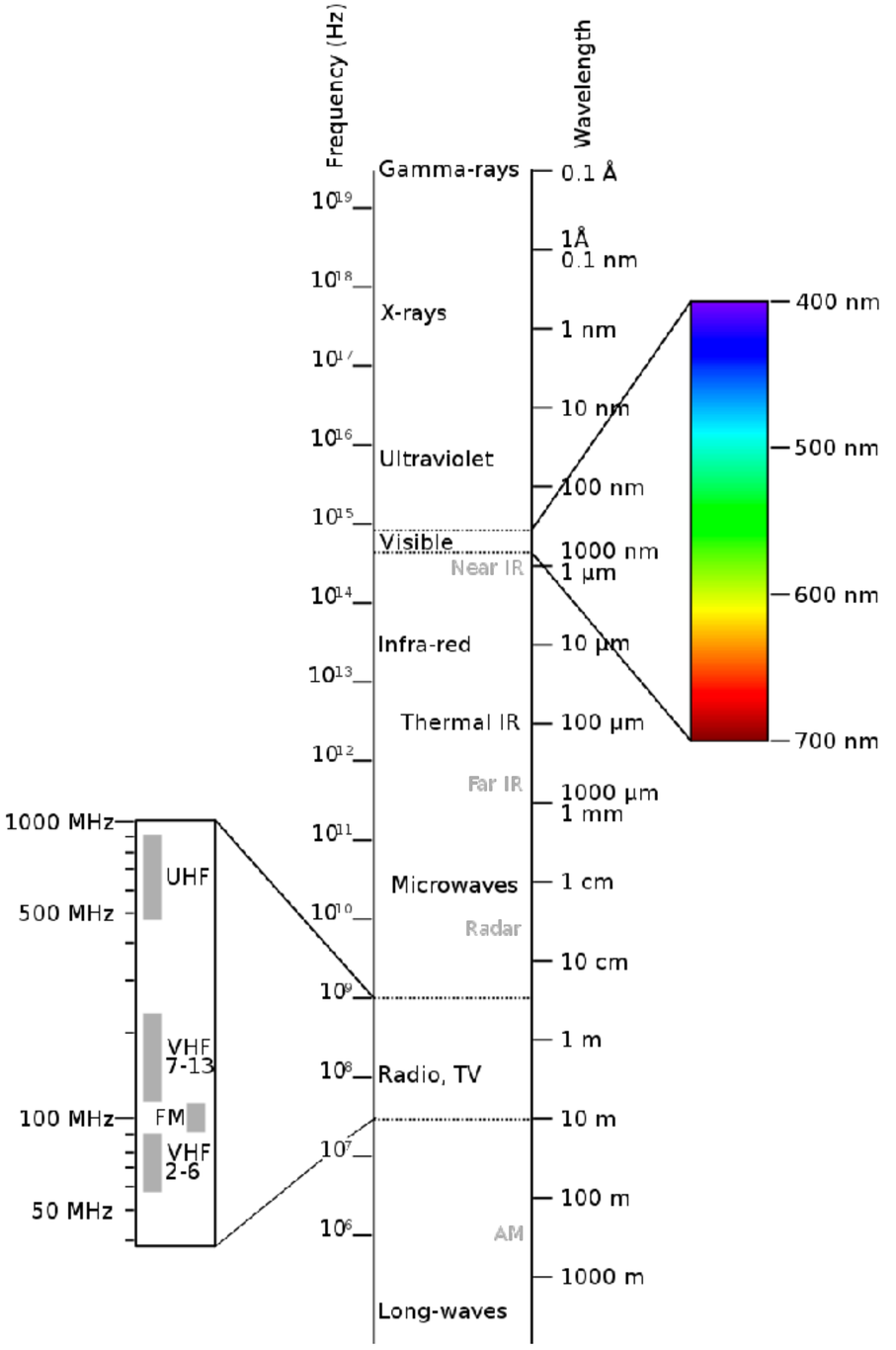
Purpose

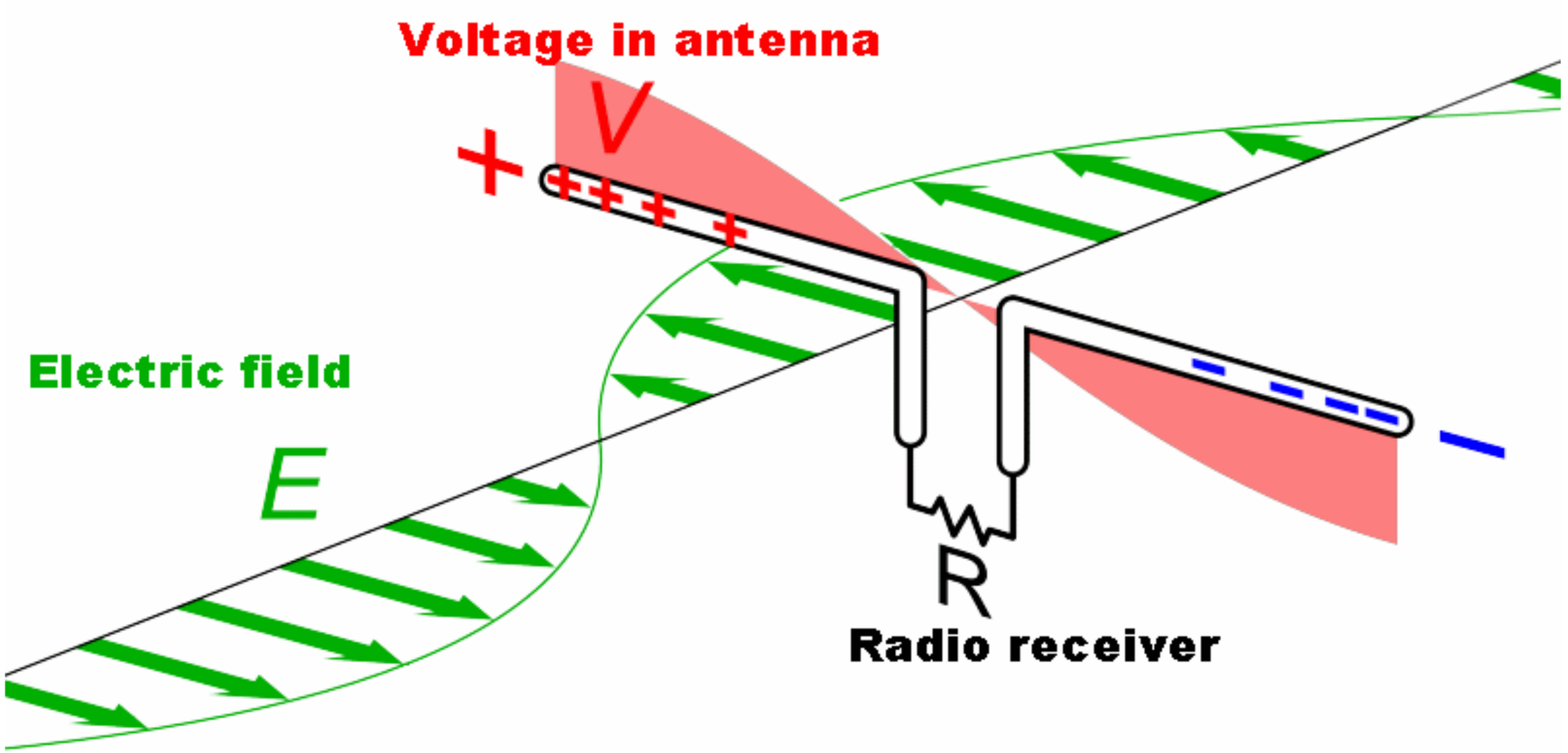
Uses

Licensing


electric field
magnetic field
A
λ
direction
of
propagation


electric field
magnetic field
A
λ
direction
of
propagation


Frequency (Hz)
Wavelength
Gamma-rays
X-rays
Ultraviolet
Visible
Near IR
Infra-red
Thermal IR
Far IR
Microwaves
Radar
Radio, TV
AM
Long-waves
0.1 Å
1Å
0.1 nm
1 nm
10 nm
100 nm
1000 nm
1 µm
10 µm
100 µm
1000 µm
1 mm
1 cm
10 cm
1 m
10 m
100 m
1000 m
400 nm
500 nm
600 nm
700 nm
1000 MHz
500 MHz
100 MHz
50 MHz
UHF
VHF 7-13
FM
VHF 2-6


Voltage in antenna
V
+
Electric field
E
R
Radio receiver

Purpose

Providing emergency communications

Advancement of the radio art

Advancing skills in both the communication and technical phases of the art

Training operators, technicians, and electronics experts

Enhancing international goodwill

FCC Part 97

https://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=336ab7469b61ecbfa15086dbf1bf2c59&rgn=div5&view=text&node=47:5.0.1.1.6&idno=47#47:5.0.1.1.6.1.157.1

Restrictions

No Commercial Use

Operating Limits

Varies by frequency range and license type, but max power is often defined.
In the US, typically 1.5 kilowatt.

Limits on political discussions

Emergency Communications

Contests

Community/Social

Experimentation

Emergency Communications

self sustained/off the grid

Contests

High power

Community/Social

Clubs, chat

Experimentation

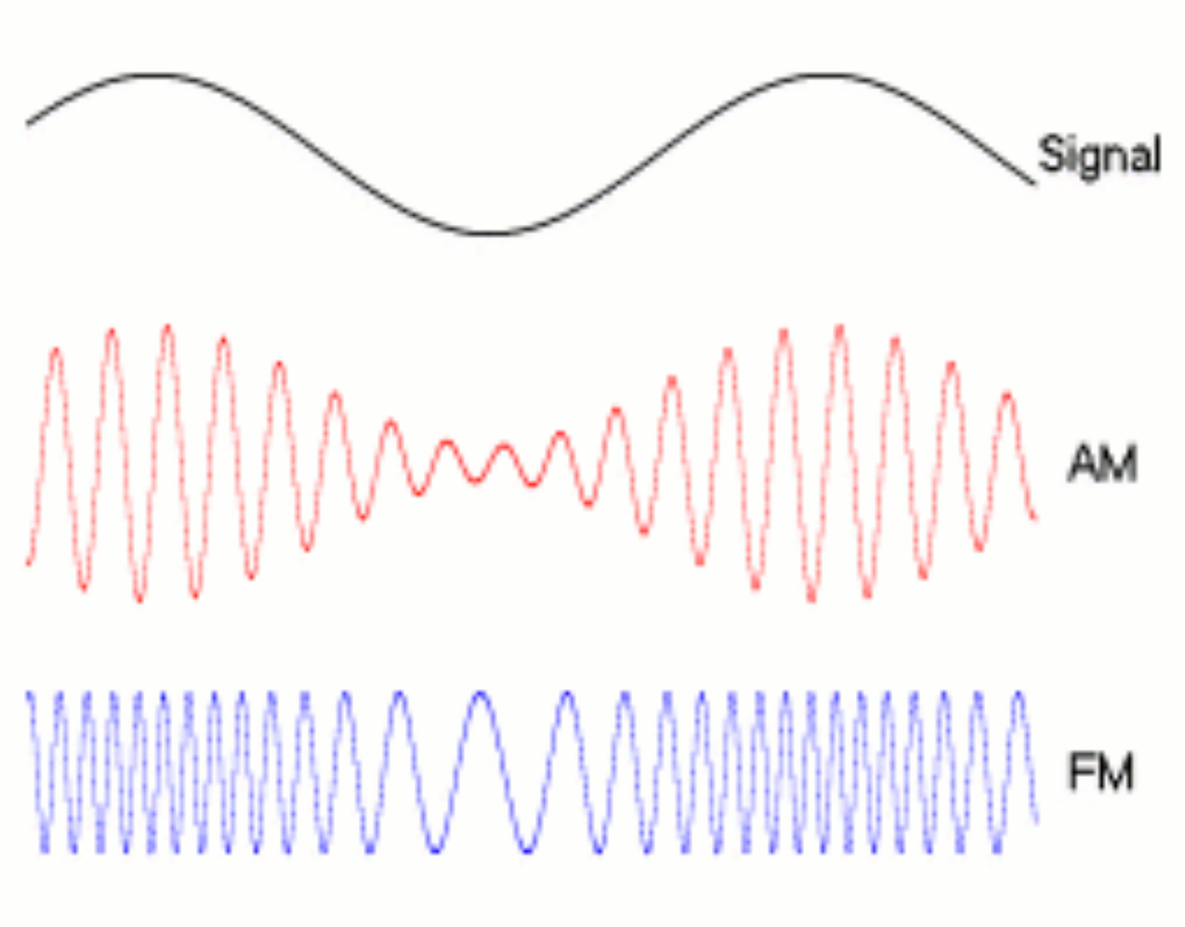
Antenna design, DIY radios, etc

Contact

Exchange of basic information and verification of contact:

Callsigns
Reception Report
Location

Analog



Digital

Morse Code (CW)
Radio teletype (RTTY)
RadioFax
PSK
FT8
JT65
Olivia
…

Radio Bands

Frequency ranges, typically described by their wavelength
20 Meter, 6 Meter, 70 Centimeter, etc

Medium and Low Frequency

2200m through 160m

“Ground wave”

High Frequency

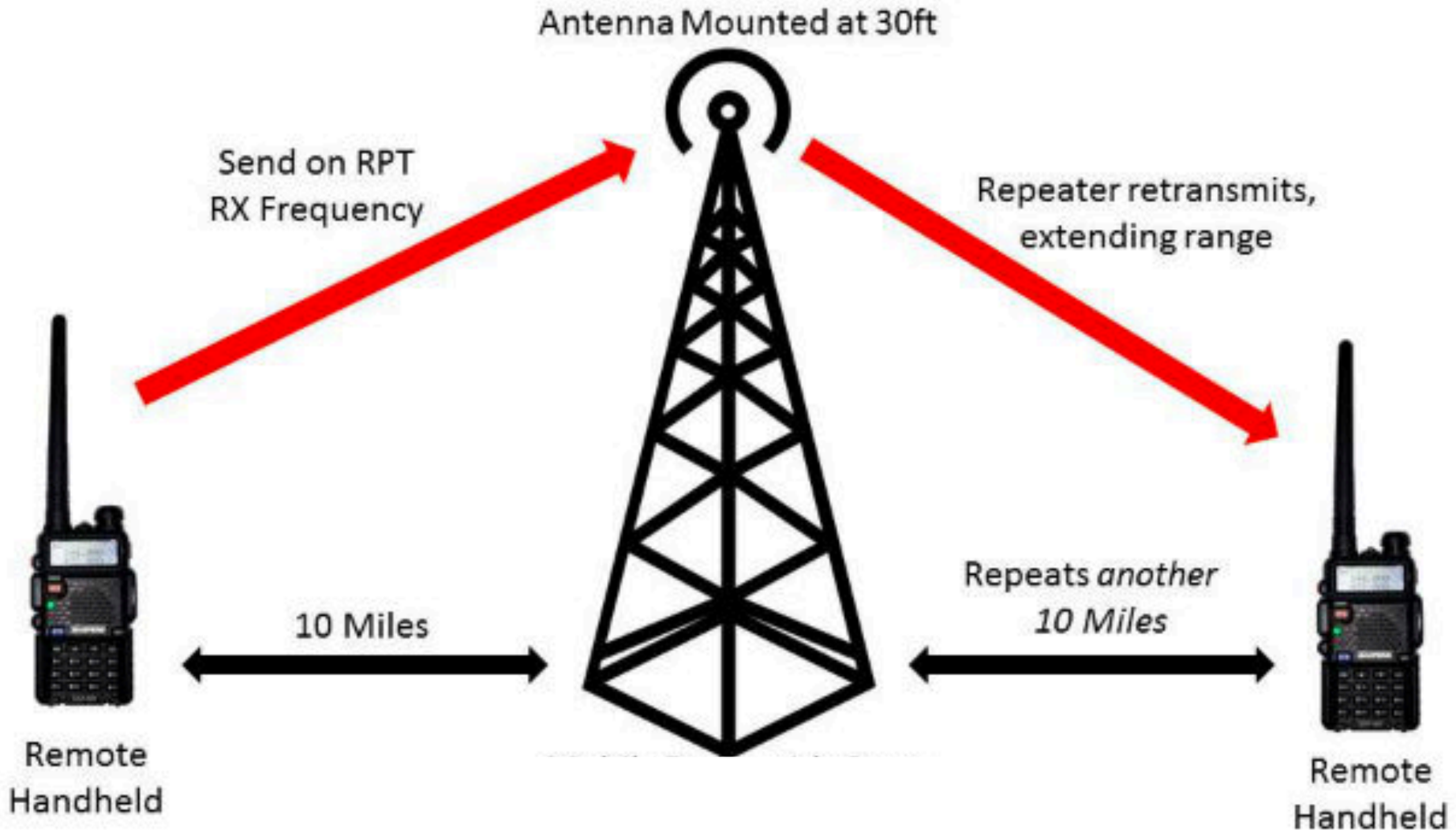
80m through 10m

“Skywave”

Very High Frequency

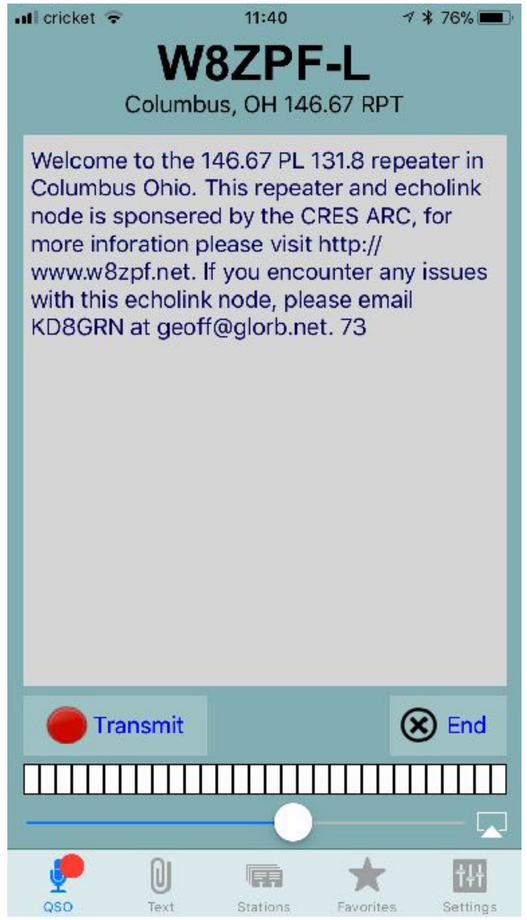
6m, 2m, and 1.25m

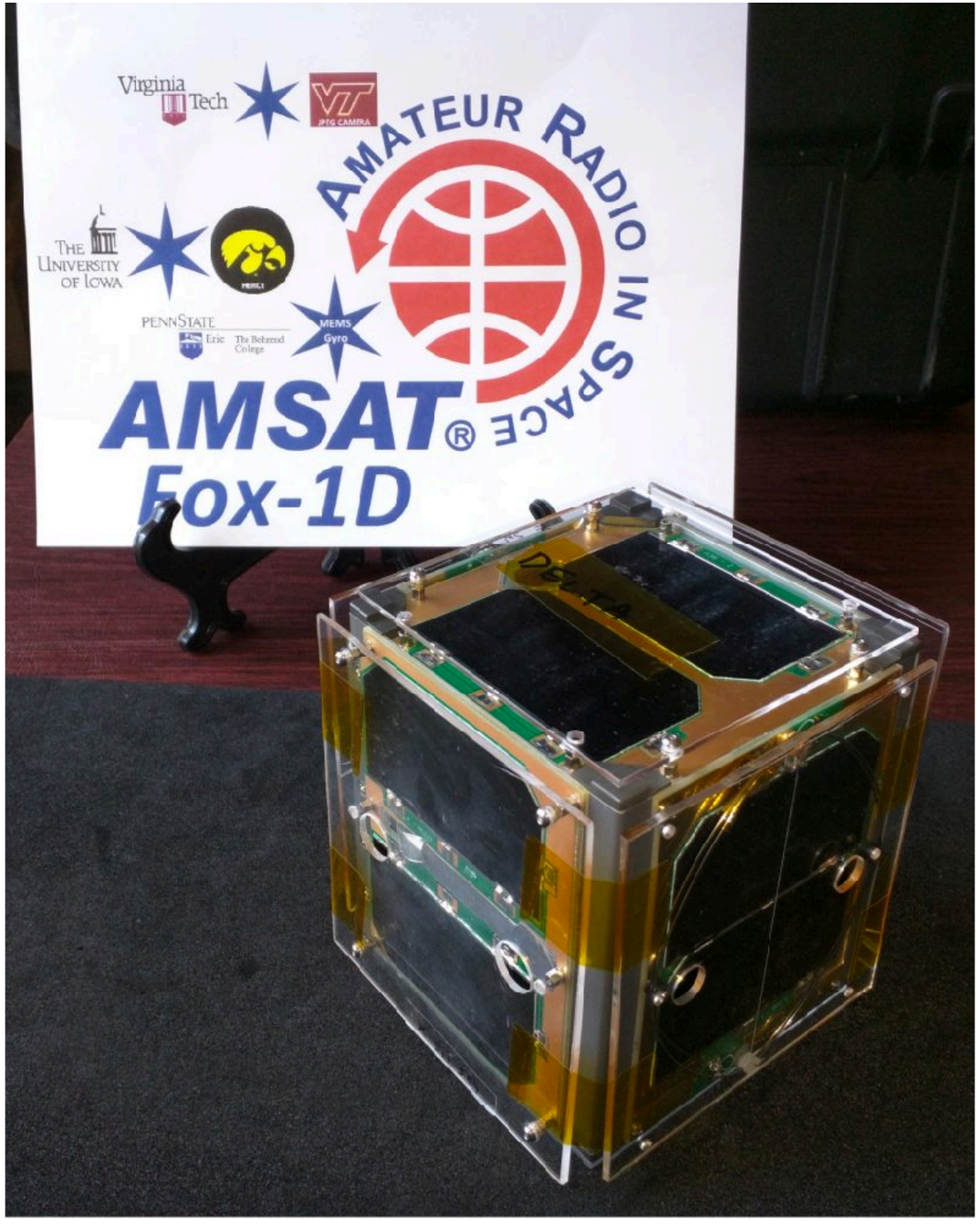
“Line of sight”


Antenna Mounted at 30ft
Send on RPT
RX Frequency
Repeater retransmits,
extending range
10 Miles
Repeats *another*
10 Miles
Remote
Handheld
Remote
Handheld

VOIP Repeater Linking

IRLP (Internet Radio Linking Project)
Echolink
Allstar (Asterisk PBX based)




Virginia Tech
VT
JPTG CAMERA
AMATEUR RADIO IN SPACE
THE UNIVERSITY OF IOWA
MERLI
PENNSTATE
Erie The Behrend College
MEMS Gyro
AMSAT®
Fox-1D

UHF+

70cm - microwaves

“Line of sight”

Public service, Wifi, Cellular

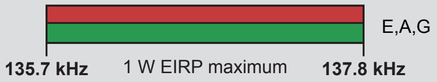
US Amateur Radio Bands

US AMATEUR POWER LIMITS — FCC 97.313 An amateur station must use the minimum transmitter power necessary to carry out the desired communications. (b) No station may transmit with a transmitter power exceeding 1.5 kW PEP.

ARRL The national association for AMATEUR RADIO®

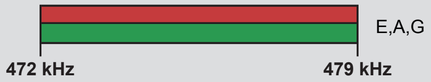
Amateurs wishing to operate on either 2,200 or 630 meters must first register with the Utilities Technology Council online at **https://utc.org/plc-database-amateur-notification-process/.** You need only register once for each band.

2,200 Meters (135 kHz)



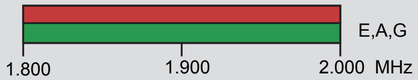
630 Meters (472 kHz)

5 W EIRP maximum, except in Alaska within 496 miles of Russia where the power limit is 1 W EIRP.

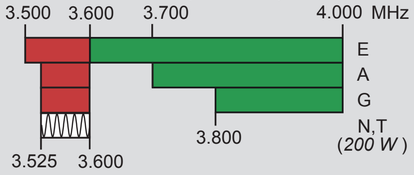


160 Meters (1.8 MHz)

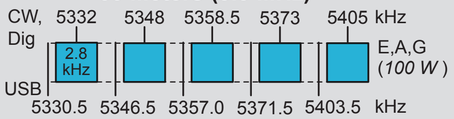
Avoid interference to radiolocation operations from 1.900 to 2.000 MHz



80 Meters (3.5 MHz)

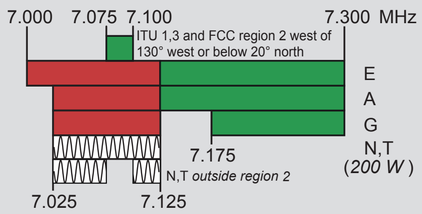


60 Meters (5.3 MHz)



General, Advanced, and Amateur Extra licensees may operate on these five channels on a secondary basis with a maximum effective radiated power (ERP) of 100 W PEP relative to a half-wave dipole. Permitted operating modes include upper sideband voice (USB), CW, RTTY, PSK31 and other digital modes such as PACTOR III. Only one signal at a time is permitted on any channel.

40 Meters (7 MHz)

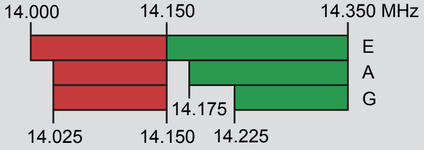


See Sections 97.305(c), 97.307(f)(11) and 97.301(e).These exemptions do not apply to stations in the continental US.

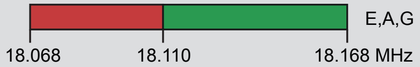
30 Meters (10.1 MHz)

Avoid interference to fixed services outside the US.

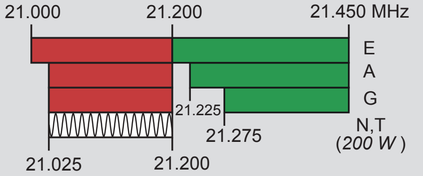
20 Meters (14 MHz)



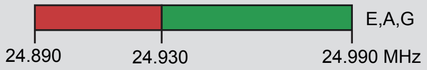
17 Meters (18 MHz)



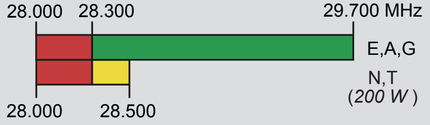
15 Meters (21 MHz)



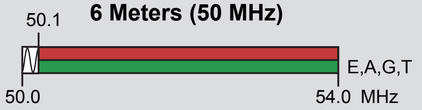
12 Meters (24 MHz)



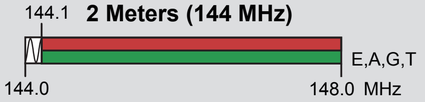
10 Meters (28 MHz)



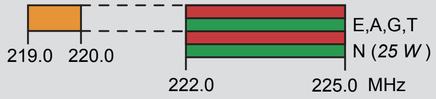
6 Meters (50 MHz)



2 Meters (144 MHz)



1.25 Meters (222 MHz)

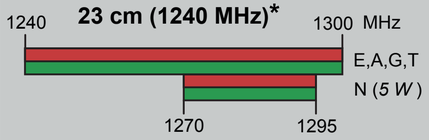


*Geographical and power restrictions may apply to all bands above 420 MHz. See *The ARRL Operating Manual* for information about your area.

70 cm (420 MHz)*

33 cm (902 MHz)*

23 cm (1240 MHz)*



All licensees except Novices are authorized all modes on the following frequencies:

2300-2310 MHz	10.0-10.5 GHz ‡	122.25-123.0 GHz
2390-2450 MHz	24.0-24.25 GHz	134-141 GHz
3300-3500 MHz	47.0-47.2 GHz	241-250 GHz
5650-5925 MHz	76.0-81.0 GHz	All above 275 GHz

‡ No pulse emissions

KEY

Note:

CW operation is permitted throughout all amateur bands.

MCW is authorized above 50.1 MHz, except for 144.0-144.1 and 219-220 MHz.

Test transmissions are authorized above 51 MHz, except for 219-220 MHz

- = RTTY and data
- = phone and image
- = CW *only*
- = SSB phone
- = USB phone, CW, RTTY, and data
- = Fixed digital message forwarding systems *only*

E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice

See *ARRLWeb at www.arrl.org* for detailed band plans.

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 rev. 9/22/2017

AREDN™
AMATEUR RADIO EMERGENCY DATA NETWORK

TP-Link

TP-Link CPE210 2.4GHz 300Mbps 9dBi High Power Outdoor CPE/Access Point, 2.4GHz 300Mbps, 802.11b/g/n, dual-polarized 9dBi directional antenna, Passive POE (CPE210)

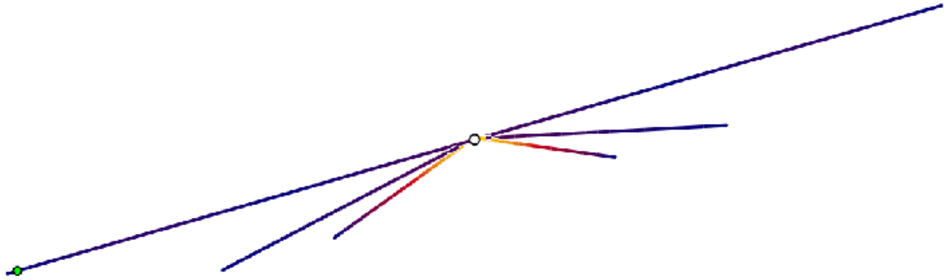
★★★★☆ 189 customer reviews | 174 answered questions

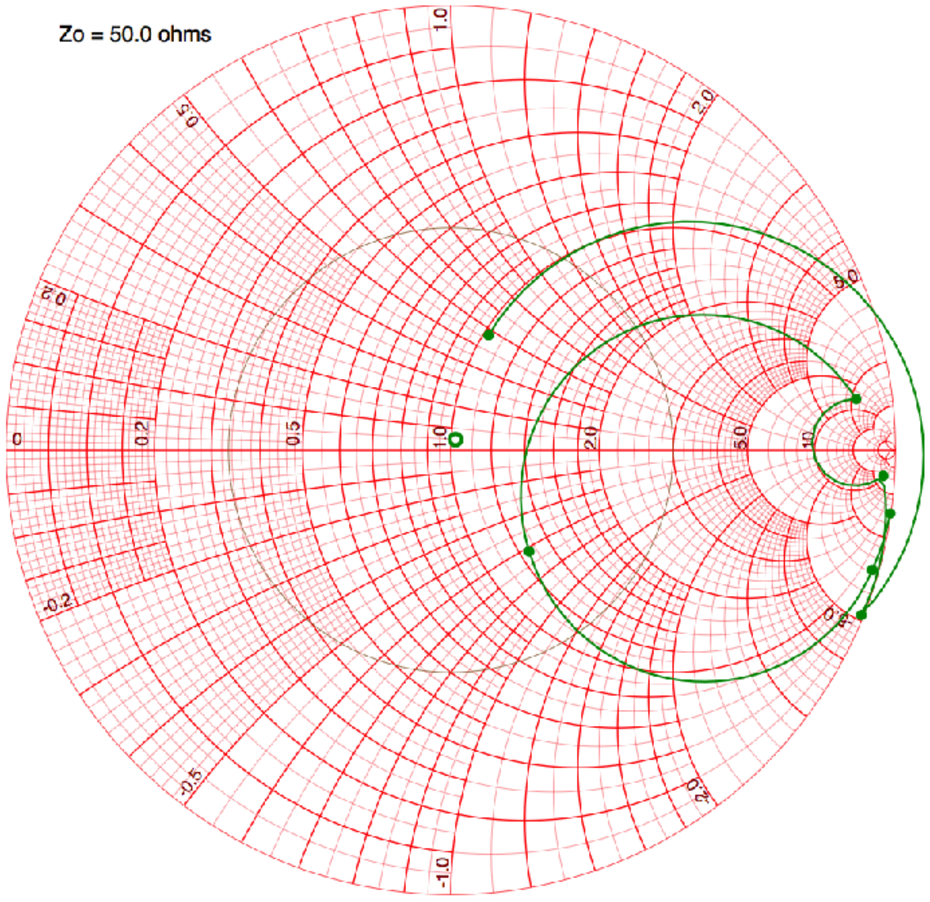
Price: $39.99 ✓prime | FREE One-Day

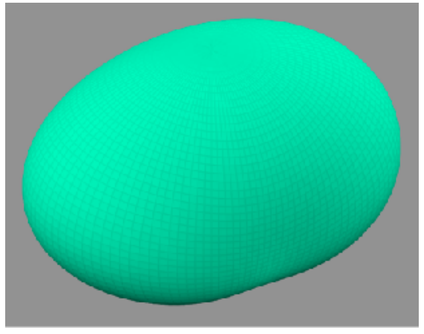
NEC Modeling language

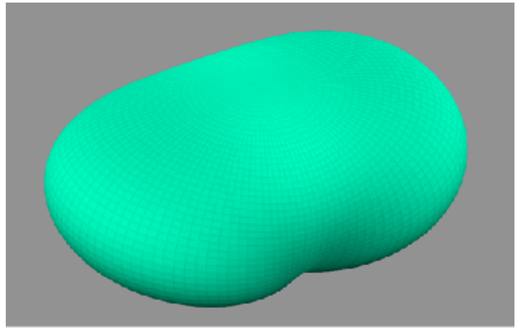
CocoaNEC (OSX)
4Nec2 (Windows)

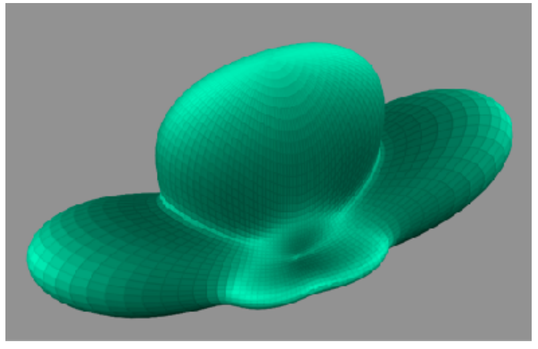
```
model( "Fan dipole" )
{
     real height, drop, segment;
     real len20m, len10m, len6m;

     height = 15';
     drop = 20";

     len20m = 5.0;
     len10m = 2.7;
     len6m = 1.51;


     voltageFeed(wire( 0, -2", height, 0, 2", height, #14, 21 ), 1.0, 0.0) ;
     wire( 0, 2", height, 0, len20m, height, #14, 21 );
     wire( 0, -len20m, height, 0, -2", height, #14, 21 );
     wire( 0, -len10m, height-drop, 0, -2", height, #14, 21 );
     wire( 0, 2", height, 0, len10m, height-drop, #14, 21 );
     wire( 0, -len6m, height-drop, 0, -2", height, #14, 21 );
     wire( 0, 2", height, 0, len6m, height-drop, #14, 21 );

     setFrequency(14.08);
     //setFrequency(28.2);
     //setFrequency(50.4);
     poorGround();
     addFrequency(7.05);
     addFrequency(10.15)
     //addFrequency(14.08);;
     addFrequency(18.068);
     addFrequency(21.1);
     addFrequency(24.9);
     addFrequency(28.2);
     addFrequency(50.4);
}


control()
{
     runModel() ;
}
```




Zo = 50.0 ohms
1.0
2.0
3.0
4.0
5.0
10
0
0.2
0.5
1.0
2.0
5.0
10
0
-0.2
-0.5
-1.0
-2.0
-3.0
-4.0
-5.0







Getting Licensed

Technician

Basic Privileges

General

More Access

Amateur Extra

Full Access

References

www.arrl.org:
- Study Materials
- Exam Sessions (Usually $15)
- Advocacy/Membership

hamstudy.org:
- Licensing Test Preparation
- Test Questions

https://www.laurelvec.com/
- Test Sessions (Free)

https://www.amsat.org/

Questions?

https://github.com/chills42/codemash-hamradio