# Short and Mobile Antennas

# Caution

- Look out for power lines
- The ends of an antenna are high voltage points
- Radiation to friends, family, and you

# Basic Concepts

- There is very little difference in gain between a full size antenna and a small one
  - .31db
- Any power going into an antenna either radiates or is lost in heat
  - Resistance is a major loss in small antennas
- To make an efficient small antenna we must identify the losses and reduce them as much as possible

# Small Transmitting Loop Antenna

- Constructed out of 1” copper pipe
- 75” on a side (fit through a standard door)
- Tunes 3.5 to 11 MHz
- Good for 1 KW
- Trombone style tuning capacitor

# Loop Calculations at 3.5 MHz

- Radiation resistance =.0078 ohms
- Resistance of copper pipe =.042 ohms
- Loss =8 DB
- Current at 1 KW =100 amps RMS
- Voltage on the capacitor =20,000 peak
- Bandwidth =2.4 KHz

# Small Antennas in General

- Very low radiation resistance
  - Therefore poor efficiency if the antenna resistance is not reduced
- Very high voltages
- Narrow band width

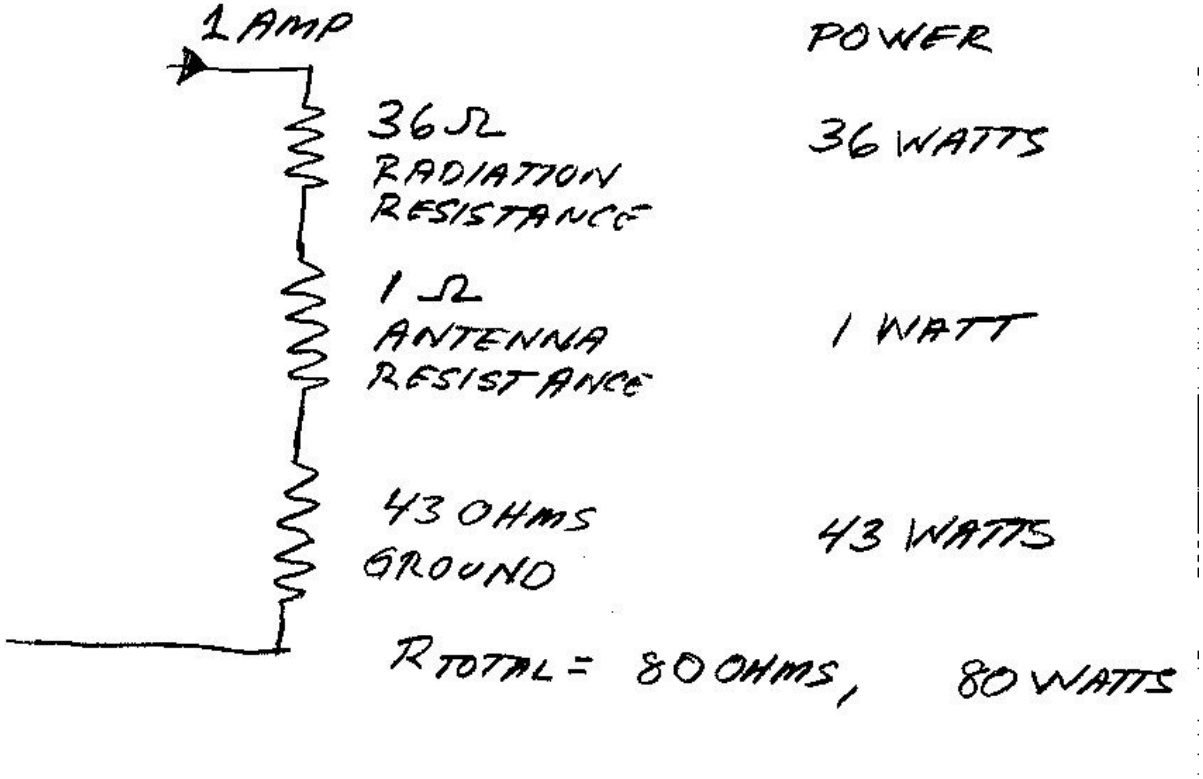
# Radiation Resistance

- Dipole
  - 72 ohms
- Folded dipole
  - 300 ohms
- Vertical
  - 36 ohms

# Radiation Resistance
# 8 Foot Whip

- Over perfect ground:
  - 28MHz =35 ohms (1.7 A for 100 w)
  - 14 MHz =15 ohms (2.5 A )
  - 7 MHz =5.5 ohms (4.2 A )
  - 3.5 MHz =.27 ohms (19 A )
  - 1.8 MHz =.07 ohms (37 A )

# Equivalent Circuit for a Vertical



# Ground Resistance

- Ground resistance is a major loss in ground mounted verticals

Reference:Vertical Antenna Classics
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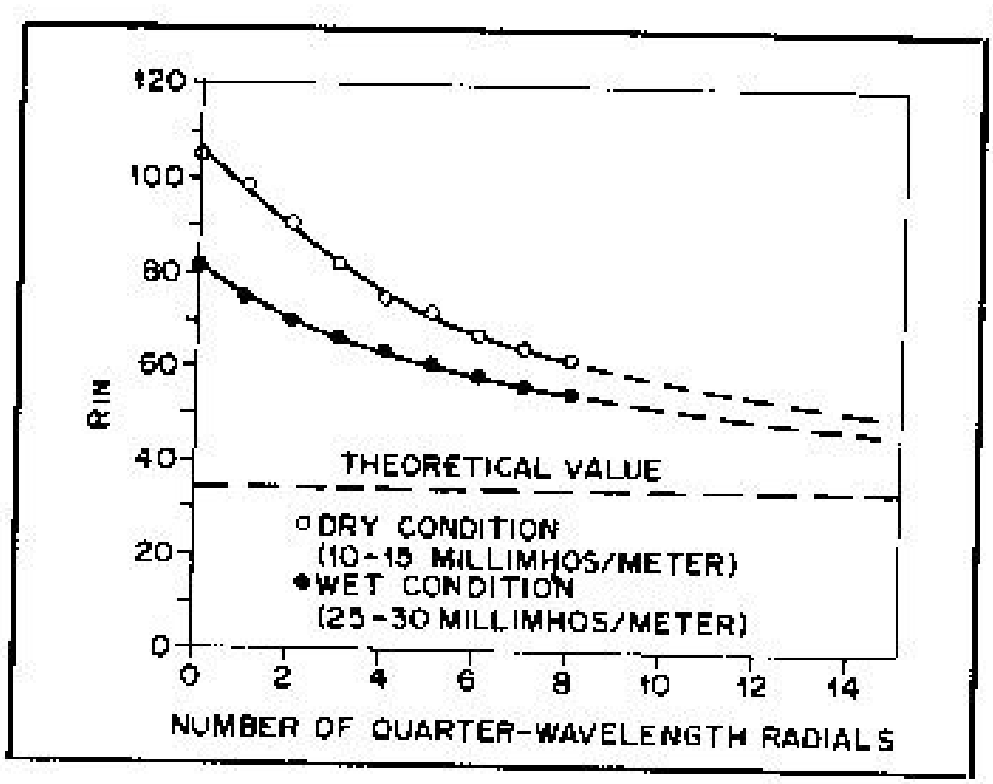


Fig. 4 — Input impedance of resonant quarter-wavelength vertical as a function of the number of radials and the condition of the soil.

# More is better!

- Unless you are putting more than 20 radials in, keep them short

Reference: Vertical Antenna Classics
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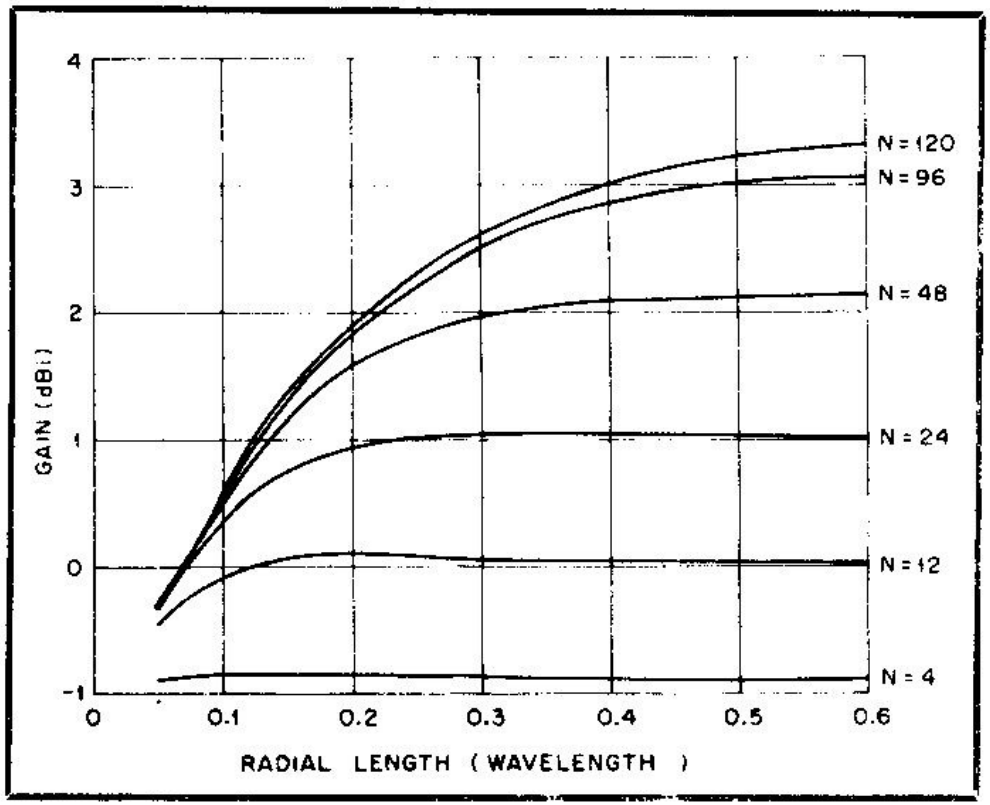


Fig. 1—Gain vs. radial number and length for poor earth conditions (X = 0.0001, $\epsilon_r$ = 7).

# Elevated Radials

Reference:Vertical antenna Classics
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- If possible: get them up in the air

**Table 7**

**Calculated Power Gain and Electric Field Strength for Isolated Vertical Antenna Systems with 2 Radials**

| | *Calculated power gain (dBi)* | | | | | |
|---|---|---|---|---|---|---|
| | *1/4-λ monopole 1/8-λ radials* | | | *1/4-λ monopole 1/4-λ radials* | | |
| *Elevation angle (degrees)* | *Azimuth angle (degrees)* | | | *Azimuth angle (degrees)* | | |
| | *0* | *45* | *90* | *0* | *45* | *90* |
| 0 | − ∞ | − ∞ | − ∞ | − ∞ | − ∞ | − ∞ |
| 5 | −6.29 | −6.25 | −6.21 | −6.12 | −6.03 | −5.90 |
| 10 | −2.61 | −2.57 | −2.53 | −2.48 | −2.36 | −2.22 |
| 15 | −1.18 | −1.13 | −1.09 | −1.10 | −0.95 | −0.78 |
| 20 | −0.64 | −0.58 | −0.53 | −0.64 | −0.43 | −0.22 |
| 25 | −0.60 | −0.53 | −0.46 | −0.69 | −0.42 | −0.16 |
| 30 | −0.90 | −0.81 | −0.73 | −1.12 | −0.77 | −0.44 |
| 40 | −2.26 | −2.13 | −2.00 | −2.81 | −2.22 | −1.72 |
| 50 | −4.43 | −4.25 | −4.07 | −5.43 | −4.53 | −3.81 |
| 60 | −7.41 | −7.16 | −6.93 | −8.90 | −7.63 | −6.68 |
| 70 | −11.45 | −11.14 | −10.86 | −13.40 | −11.78 | −10.63 |
| 80 | −17.87 | −17.52 | −17.19 | −20.11 | −18.26 | −16.97 |
| 90 | −157.65 | −157.65 | −157.65 | −149.71 | −149.71 | −149.71 |
| *Vertical electric field strength (mV/m)* | 32.72 | 32.84 | 32.97 | 33.35 | 33.67 | 34.15 |
| *Input impedance (ohms)* | 36.81 − *j*263.26 | | | 34.92 + *j*0.83 | | |

# Elevated Radials

- Works even with short antennas

**Table 9**

**Calculated Power Gain and Electric Field Strength for Isolated Vertical Antenna Systems with 1 Radial**

| | *Calculated power gain (dBi)* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *1/8-λ monopole 1/8-λ radial* | | | | *1/8-λ monopole 1/4-λ radial* | | | |
| *Elevation angle (degrees)* | *Azimuth angle (degrees)* | | | | *Azimuth angle (degrees)* | | | |
| | *0* | *45* | *90* | *180* | *0* | *45* | *90* | *180* |
| 0 | – ∞ | – ∞ | – ∞ | – ∞ | – ∞ | – ∞ | – ∞ | – ∞ |
| 5 | –8.54 | –8.88 | –10.84 | –17.05 | –6.96 | –7.28 | –8.33 | –10.58 |
| 10 | –4.76 | –5.01 | –6.79 | –13.72 | –3.19 | –3.50 | –4.54 | –6.90 |
| 15 | –3.13 | –3.29 | –4.88 | –12.93 | –1.61 | –1.90 | –2.92 | –5.47 |
| 20 | –2.31 | –2.36 | –3.75 | –13.42 | –0.85 | –1.12 | –2.14 | –4.93 |
| 25 | –1.86 | –1.80 | –3.00 | –14.95 | –0.52 | –0.77 | –1.79 | –4.90 |
| 30 | –1.63 | –1.46 | –2.48 | –17.44 | –0.46 | –0.69 | –1.71 | –5.21 |
| 40 | –1.41 | –1.10 | –1.82 | –17.11 | –0.83 | –1.03 | –2.08 | –6.55 |
| 50 | –1.19 | –0.87 | –1.42 | –10.19 | –1.58 | –1.78 | –2.88 | –8.36 |
| 60 | –0.88 | –0.69 | –1.16 | –5.93 | –2.52 | –2.75 | –3.89 | –9.51 |
| 70 | –0.59 | –0.56 | –0.99 | –3.32 | –3.56 | –3.82 | –4.91 | –8.99 |
| 80 | –0.52 | –0.59 | –0.89 | –1.72 | –4.68 | –4.92 | –5.68 | –7.49 |
| 90 | –0.85 | –0.85 | –0.85 | –0.85 | –5.97 | –5.97 | –5.97 | –5.97 |
| *Vertical electric field strength (mV/m)* | 24.75 | 23.45 | 18.09 | 9.90 | 29.95 | 28.79 | 25.48 | 20.18 |
| *Input impedance (ohms)* | 23.49 – *j*527.41 | | | | 12.22 – *j*1004.27 | | | |

# Mobil Antennas

- A vehicle is like a short elevated radial
- Get the radiation resistance up by center loading, top hats

# 160 Meter Vertical

Reference: Vertical Antenna Classics
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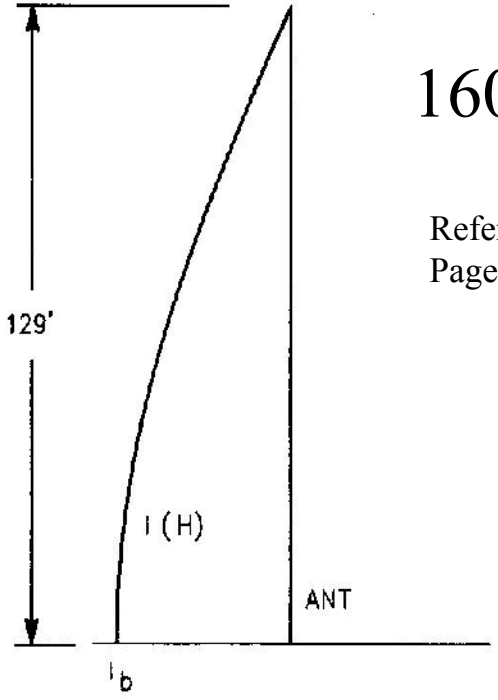
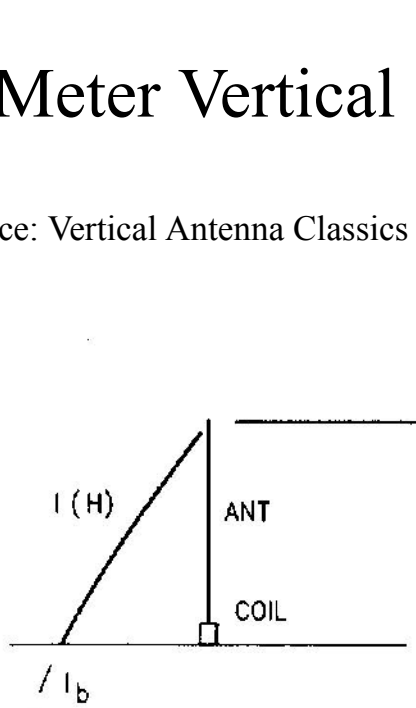
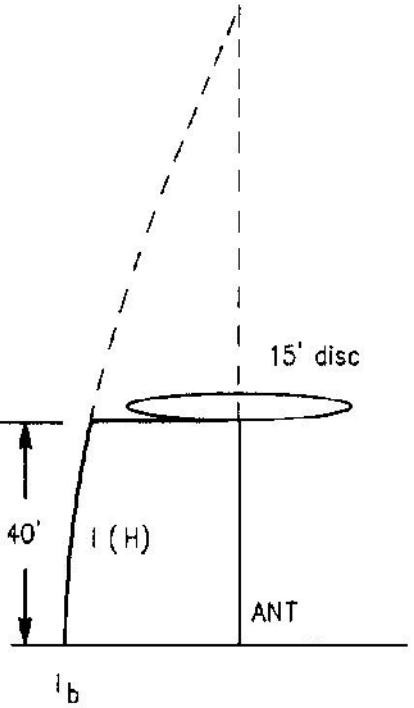
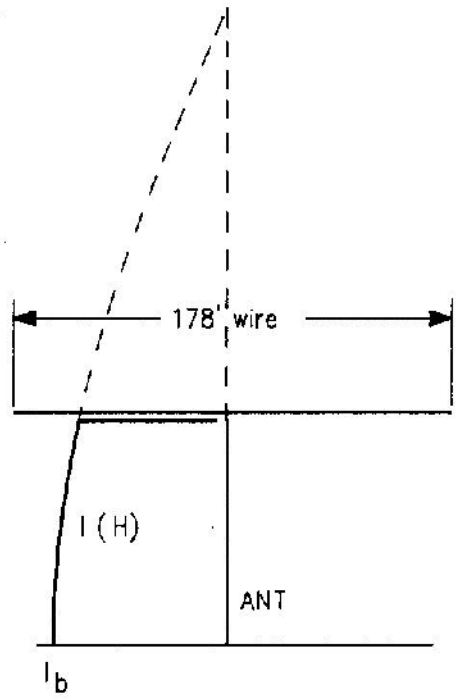


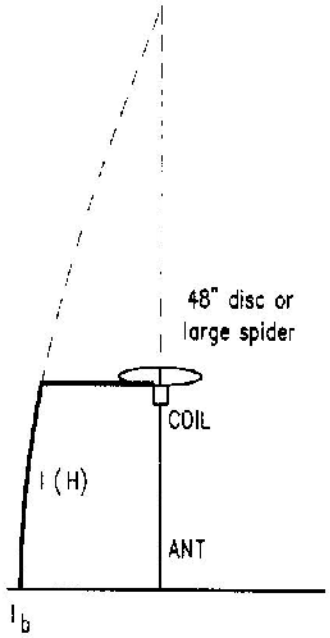



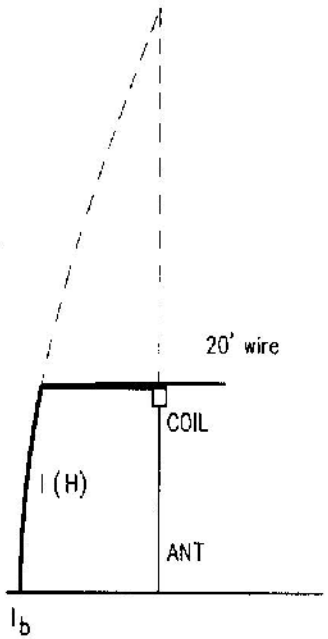



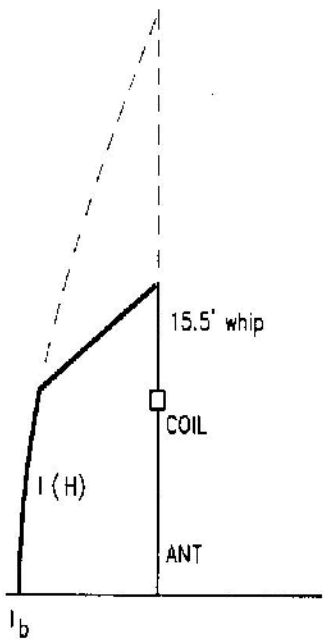

| Antenna no. | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $R_r$ | 36.6 | 2.24 | 7.96 | 7.96 |
| $R_g$ | 15 | 15 | 15 | 15 |
| $R_c$ | – | 2.3 | – | – |
| $R_b$ | 51.6 | 19.54 | 22.96 | 22.96 |
| 100 W $I_b$ | 1.39 | 2.26 | 2.09 | 2.09 |
| $P_r$ or $R_{eff}$ | 71 | 11.5 | 34.7 | 34.7 |

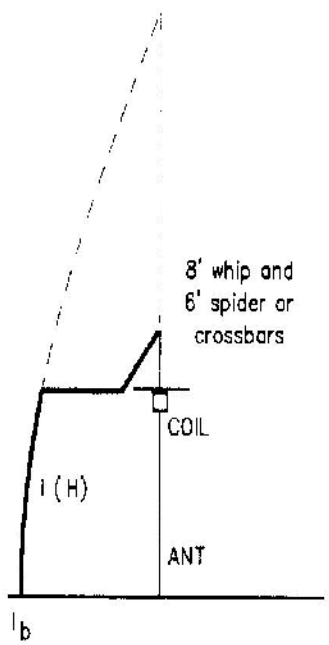
# 160 Meter Vertical

Reference Vertical antenna Classics
Page 87




| Antenna no. | (5) | (6) | (7) |
|---|---|---|---|
| $R_r$ | 7.96 | 11.06 | 7.96 |
| $R_g$ | 15 | 15 | 15 |
| $R_c$ | 4.6 | 4.6 | 4.6 |
| $R_b$ | 27.56 | 30.66 | 27.56 |
| 100 W $I_b$ | 1.90 | 1.81 | 1.90 |
| $P_r$ or $R_{eff}$ | 28.9 | 36.1 | 28.9 |

# Mobil Antennas

- Pay lot of attention to grounding to the vehicle
- Use as large of diameter mast as possible
- Check for heat after transmitting

# Ground Loss Resistance for a Mobile Antenna



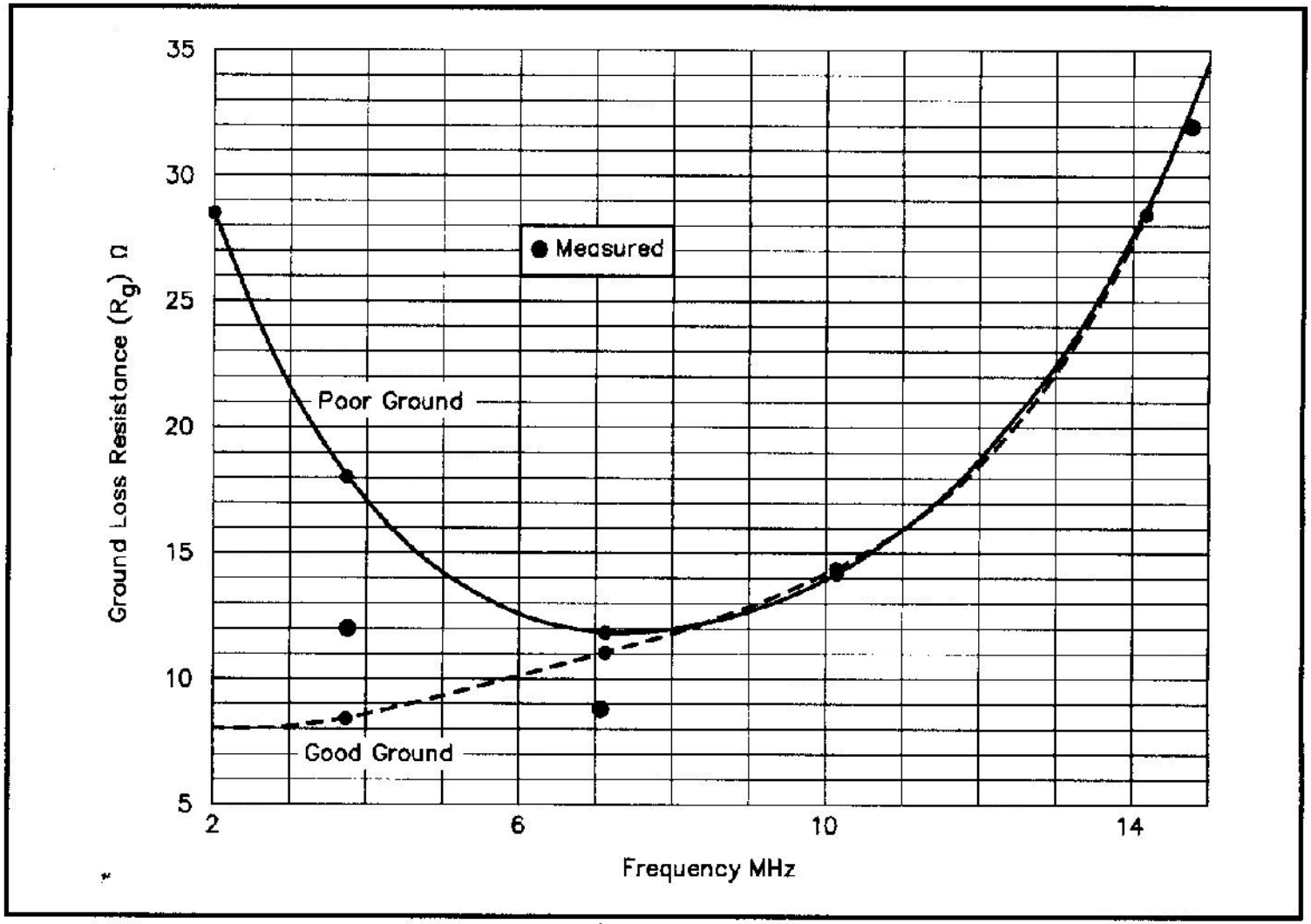



**Fig 3—Ground loss resistance ($R_g$) measured (see text), and calculated using *NEC-2* for an electrically short HF mobile antenna on the basic frame of the vehicle, for two ground conductivities.**

# Shorten Antennas

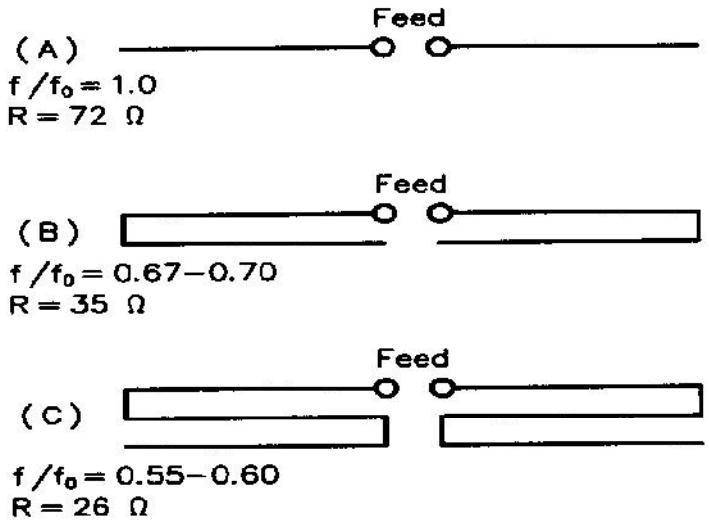



**Fig 38—Wire dipole antennas. The ratio $f/f_0$ is the measured resonant frequency divided by frequency $f_0$ of a standard dipole of same length. R is radiation resistance in ohms. At A, standard single-wire dipole. At B, two-wire linear-loaded dipole, similar to folded dipole except that side opposite feed line is open. At C, three-wire linear-loaded dipole.**

Reference The ARRL Antenna Book 18th edition Page 6-20

# Horizontal Antennas

- Low ground losses
- Need height to be effective
  - Minimum 15 to 20 feet

# Antennas for the Deck and Patio

- Ground plane
  - Radials along the deck floor
- Dipole along the hand rail
  - Load up a metal hand rail
- Load up a gutter
- A fence make a good radial
- In winter lay out lots of short radials on the grass

# Inside Antennas

- Balanced antennas
  - shortened dipoles
  - zig zag
- Unbalanced
  - Random wire
  - Aluminum windows
  - ground connections are radiators

# Indoor Antenna Cautions

- Radiation
- Interference
  - To other devices in the area
  - From other devices
- High voltage points

# An Experimenter's Delight

- Small antennas are driven by external factors that over ride normal design considerations
- It is generally easier to try an idea that analyze it
- Most systems are low cost
  - entertainment
  - learning experience

# Evaluate the System

- Switch between 2 antenna systems
- Compare your signal with a friend and other stations
- Try to improve the antenna based on our discussion
- Have fun!!

# Conclusions

- While not ideal, small, mobile, or indoor antennas can be effective if:
  - Minimize ground and resistive losses
  - Maximize the radiation resistance
  - A horizontal antenna is high enough