Figure D-9. Half-wave dipole antenna.

Figure D-9 from U.S. Army Field Manual 79-3
FCC Frequency Spectrum Allocation in the US

UNUNITED STATES FREQUENCY ALLOCATIONS THE RADIO SPECTRUM

AM Radio

FM

TV

3G/4G cellular

Wi-Fi

FCC Frequency Spectrum Allocation in the US

- AM radio
- TV broadcast
- FM radio
- 3G/4G LTE cellular
- Wi-Fi
- 28 GHz – LMDS (5G cellular)
- 38 GHz 5G cellular
- 60 GHz unlicensed WiGig (802.11 ad)
- 77 GHz vehicular radar
- Active CMOS IC research

Cellular Bay Station Antennas
Cellular Telephone System

BTS = Base Transceiver Station
MSC = Mobile Switching Center
Stealth Cellular Antennas

Cacti make really good cover for antennas.
Artificial Tree Stealth Antennas

A different root system

A different root system
Parabolic Antennas for Directionality

Stanford University
Radio Astronomy Antenna

Radio, TV and microwave link antennas

NASA Tracking Station 4

Direct TV Dish Antenna
Parabolic Antennas
Applications

Parabolic antennas are used as:

- High gain antennas for point to point communication.
- In applications such as microwave relay links that carry telephone and television signals between nearby cities.
- Wireless WAN/LAN links for data communications satellite and spacecraft communication antennas.
- Radio telescopes.
- Radar antennas.
- Satellite television dish antennas.
Parabolic Antennas have High Gain

**Antenna gain** is usually **defined** as the ratio of the power produced by the **antenna** from a far-field source on the **antenna’s** beam axis to the power produced by a hypothetical lossless isotropic **antenna**, which is equally sensitive to signals from all directions.
Parabolic Antennas – Beam Width

Parabolic Dish Antenna:

\[ \text{Gain} = 6 \left( \frac{D}{\lambda} \right)^2 \]

\[ \text{Half Power Beam width} = 60 \left( \frac{\lambda}{D} \right) \]

Effective aperture = 0.6 \[ \left( \frac{\pi D^2}{4} \right) \]

Where, \( D = \text{Diameter} \)

\( \lambda = \frac{c}{f}, \quad f = \text{frequency of operation} \)

Concept of Antenna Gain

Antenna Gain
The term Antenna Gain describes how much power is transmitted in the direction of peak radiation to that of an isotropic source.

dBi is a measure of beam power relative to power of an isotropic source.
Concept of Antenna Beam Width

- Beam Width
- Radiated Side Lobes
- Maximum
- Radiated EM Power
- y
- x
- z
Antenna Used in the first Apple iPhone
The Dipole Antenna (1)
The Dipole Antenna (2)

The antenna is driven sinusoidally by alternating between voltage polarity and current direction. The alternating charges create electric fields and time-varying currents create magnetic fields. These launch by traveling waves propagating outward from the antenna.
The Dipole Antenna (3)
The Dipole Antenna (4)

https://www.pinterest.com/pin/390054017706375781/
The Dipole Antenna (5)

As typically shown in class
HDTV Antenna

North America still has some free TV signals. There are, in fact, **18 over-the-air (OTA) digital TV channels** in the Vancouver, B.C. area alone, including CBC English and French, CTV, CHEK and Global. (That is of 2017.)

**DIY HDTV antenna**

“Antenna” is two L-shaped pieces of coat hanger stripped of any coating. It is only necessary that the long sides be 6 inches (15.24 cm) in length.

- **6”** Connect to television.
- **6”** Conducting shield / ground wire.
- **6”** Terminal block screw-type electrical connector (dirt cheap at any electronics parts store).
- **6”** Copper core (must not touch ground wire).
- **6”** Coaxial cable of any length, carefully stripped to expose the two copper elements.

[https://sqwabb.wordpress.com/2017/02/12/free-your-tv-make-a-digital-antenna-for-under-10/](https://sqwabb.wordpress.com/2017/02/12/free-your-tv-make-a-digital-antenna-for-under-10/)
Monopole Antenna Derived From Dipole Antenna

https://electronics.stackexchange.com/questions/222071/how-can-i-tune-an-antenna-for-receiving-vhf
The Yagi Antenna Configuration (Yagi-Uda)

800MHz high gain antennas improve transmit and receive cellular signals used by Verizon, Alltel, US Cellular, Cellular One, Cingular, Nextel, SouthernLINC, Bell Canada, Telus, Mike and all other Cellular and iDEN carriers

https://www.alternativewireless.com/cellular-antennas/yagiantennas.html
Yagi-Uda Antenna Operates Using Interference

More Elaborate Yagi-Uda Antennas

2.4 GHz Wi-Fi outdoor Yagi antenna (18 element) with 21 dBi gain

Quad-Yagi dipole antenna with corner reflector

https://www.wifi-antennas.com/topic/103-quagi-antenna/
Phased Array Antennas – Steerable

Each radiating element is fed with a phase-shifted signal such that all the fields from the group of radiating elements sum together to steer the antenna’s beam.
Phased Array Antennas in Military Aircraft
Phased Array Antennas (Cellular)
Radio Arcala located close to Arctic Circle is an amateur radio station – consists of 36 Yagi antennas (80 meter and 160 meter)