

* Electromagnetic Spectrum

1. Audio frequency

20 - 20,000 Hz

30 Hz

\Rightarrow

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8 \text{ m/s}}{30 \text{ Hz}} = 10^7 \text{ m}$$

($\lambda/f = \frac{3}{30}$)

$$300 \text{ Hz} \Rightarrow \lambda = 10^6 \text{ m} = 1000 \text{ km}$$

2. Radio frequency

① Low freq. : 30 kHz - 300 kHz
(10 km) (1 km)

② Medium freq. : 300 kHz - 3 MHz
(100 m)

③ High freq. : 3 MHz - 30 MHz
(10 m)

④ Very High freq. : 30 MHz - 300 MHz
(VHF) (1 m)

⑤ Ultra High freq. : 300 MHz - 3 GHz
(UHF) (0.1 m)

3. Microwave (1 GHz - 1 THz)

① Centimeter wave : 3 GHz - 30 GHz
(10 cm) (1 cm)

② Millimeter wave : 30 GHz - 300 GHz

(10 mm) (1 mm)

③ Submillimeter wave : 10 Wave/cm - 100 cm⁻¹

(1 mm) (0.1 mm)

300 GHz - 3 THz

4. Infrared

① Far infrared : 100 cm⁻¹ - 1000 cm⁻¹

(10⁻⁴ m) (10⁻⁵ m)

3 THz 30 THz

② (Intermediate) infrared : 1000 cm⁻¹ - 2 eV

(10⁻⁵ m) (10⁻⁶ m)

30 THz 300 THz

$$* E = h\nu$$

$$= h \frac{c}{\lambda} \text{ [J]}, \quad c = \lambda \nu$$

↑ wave length
↑ freq.

$$\left\{ \begin{array}{l} h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s} \\ c = 3 \times 10^8 \text{ m/s} \end{array} \right.$$

↑ velocity

$$1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$$

5. Visible light : 1 eV , $\lambda < 1 \mu\text{m}$

6. Ultra violet : 1 eV - 100 eV
(10⁻⁷ m) (10⁻⁸ m)

7. X-ray : $\frac{1}{100} \text{ Hz eV} - \frac{1}{100} \text{ Hz keV}$
(10^{-9} m) ($10^{-11} - 10^{-12} \text{ m}$)

8. Gamma ray : $\frac{1}{100} \text{ Hz keV} - \frac{1}{100} \text{ Hz MeV}$
($10^{-11} - 10^{-12} \text{ m}$) ($10^{-15} - 10^{-16} \text{ m}$)
↑
femto meter

변조 (Modulation)

1. $100 \text{ Hz} \rightarrow \lambda = \frac{c}{f} = \frac{3 \times 10^8 \text{ m/s}}{100 \text{ 1/s}} = 3000 \text{ km}$
안테나 길이 = $\frac{\lambda}{2} = 1500 \text{ km}$

2. 중간 주파수 대역에 신호 끼리는 통신 방법

3. 안테나 사이즈 길이는 수 미터 이상 필요
(coupling이 어려움)

음성 신호	:	20 - 20,000 Hz
통신	:	300 - 3400 Hz
AM	:	50 - 4500 Hz
FM	:	50 - 15,000 Hz (30)

⇒ 다중 통신 필요.