Digital Voice Radio Communications Modes

Overview

* Short review of analog modes

* Discussion of digital modes

* Discussion of digital Links

* Advantages and Disadvantages

* Dongles discussions

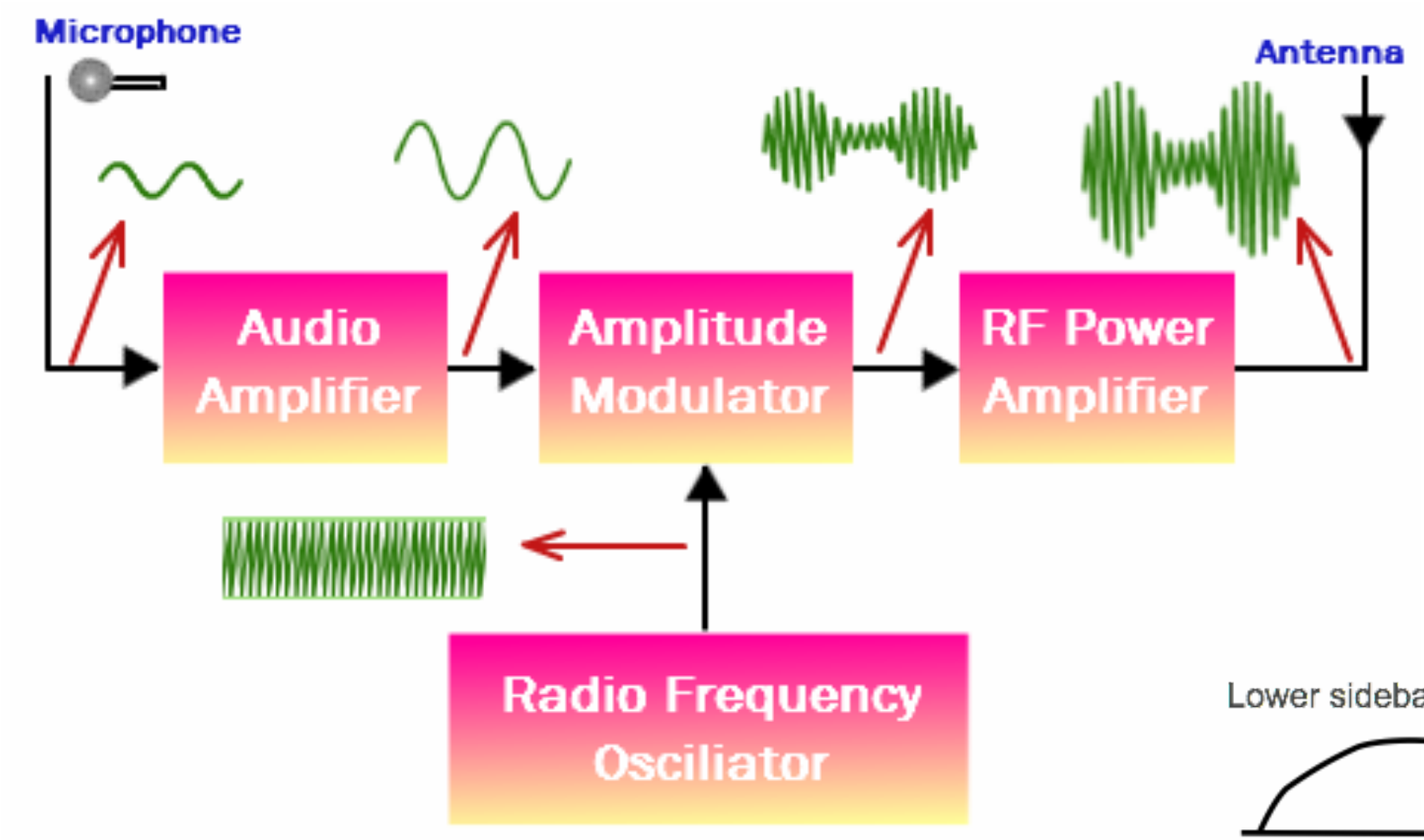
Review of Analog Modes

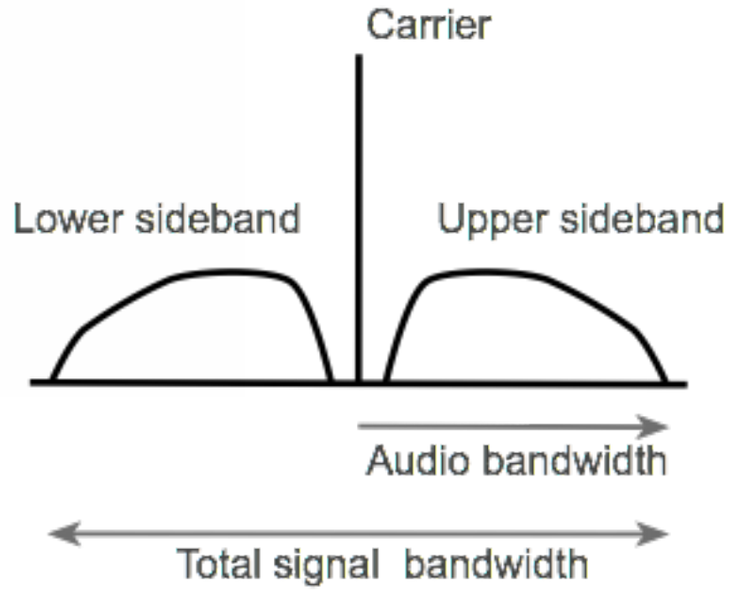
AM : Amplitude Modulation
(Single Side Band is AM)

FM : Frequency Modulation

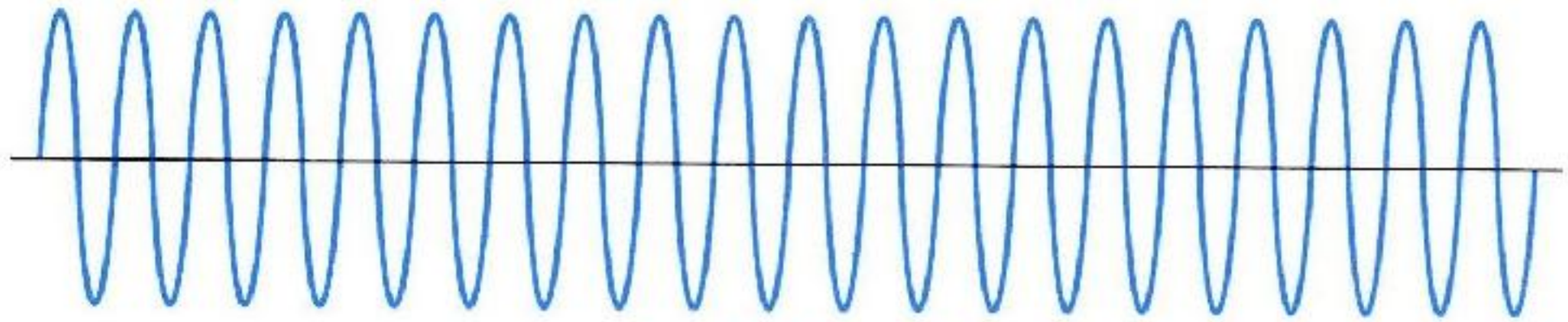
PM : Phase Modulation

MODULATION

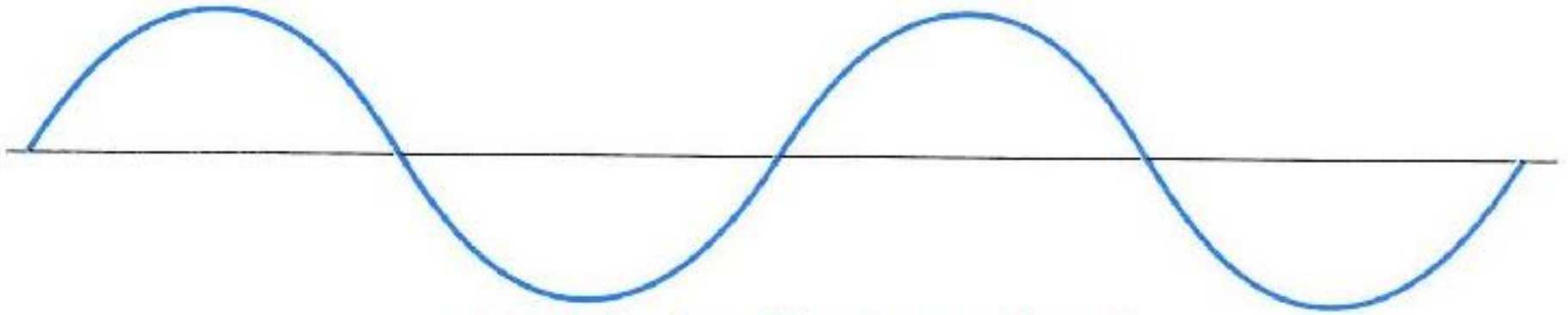




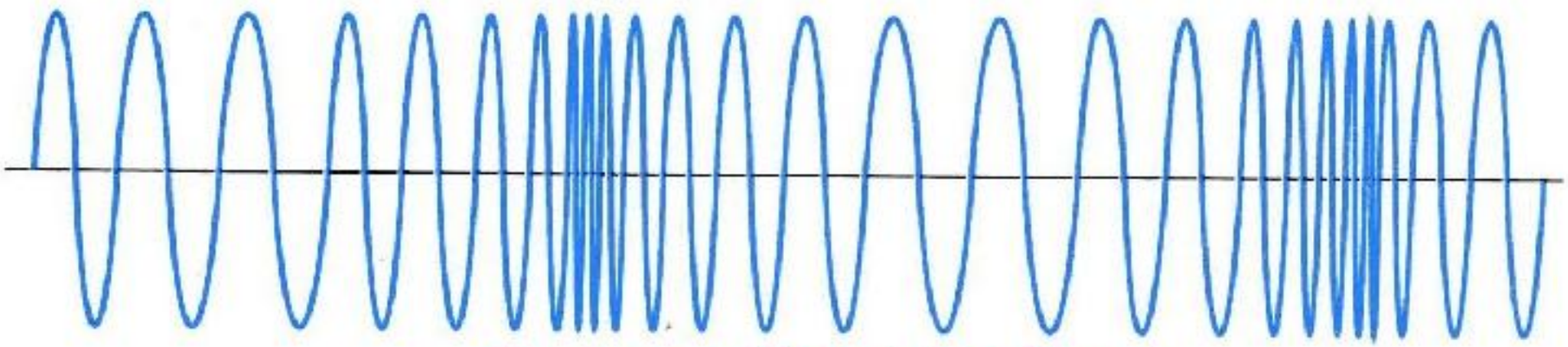
https://www.youtube.com/watch?v=0aEFDgR6oJM



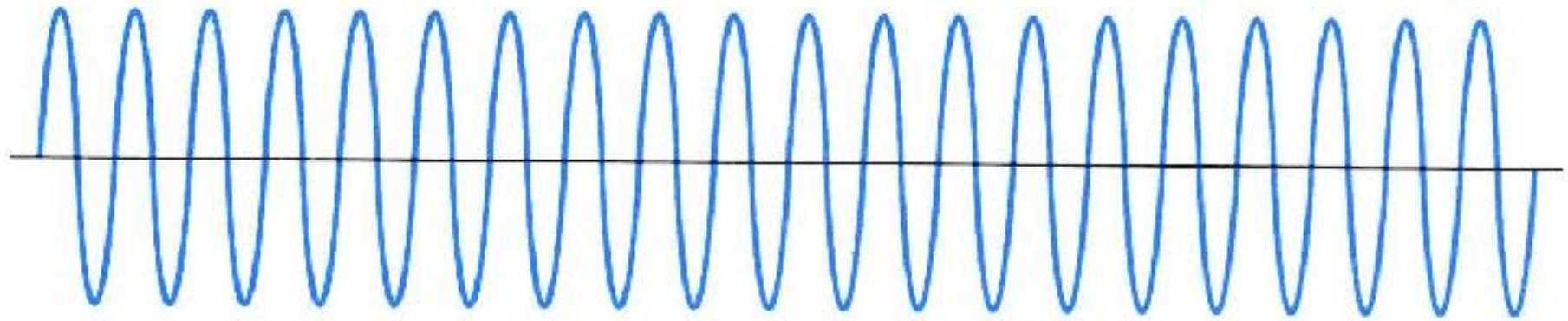
Carrier Signal



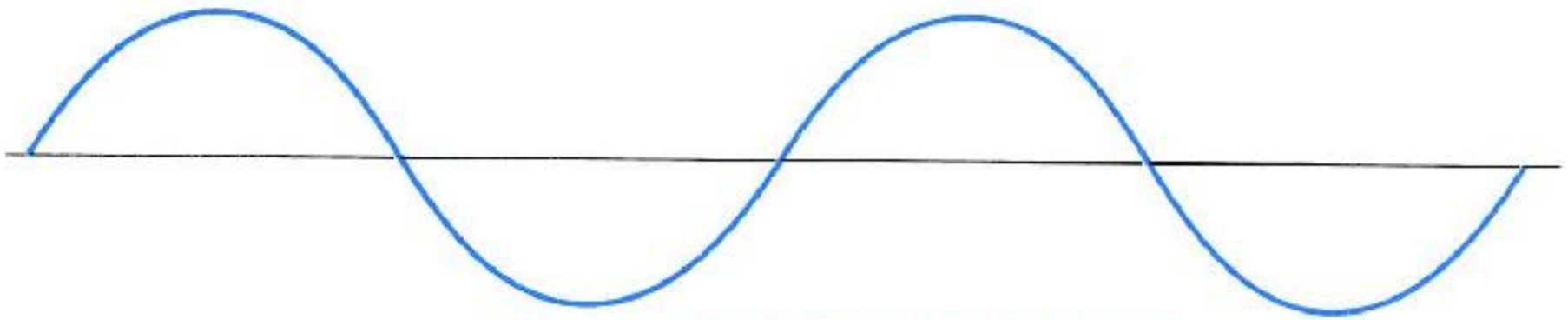
Modulating Sin Wave Signal



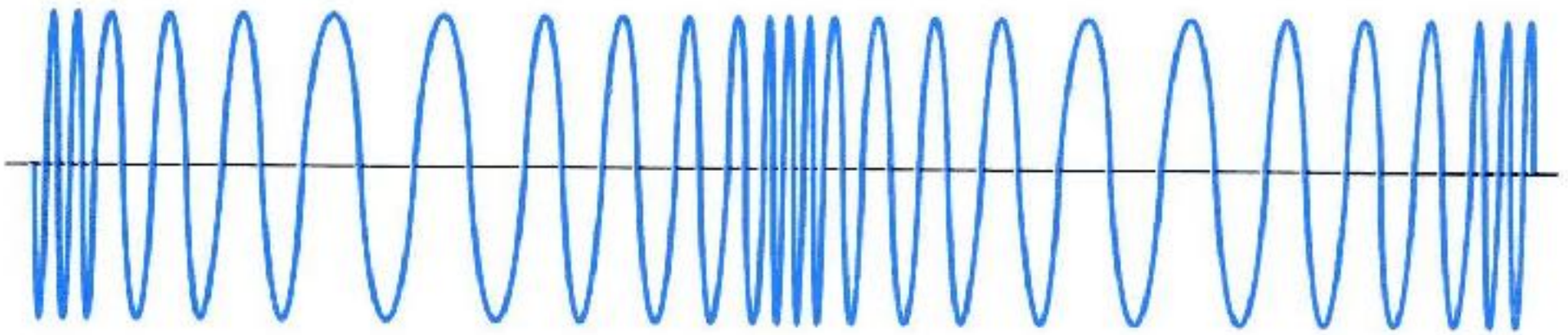
Frequency Modulated Signal



Carrier Signal



Modulating Sine Wave Signal

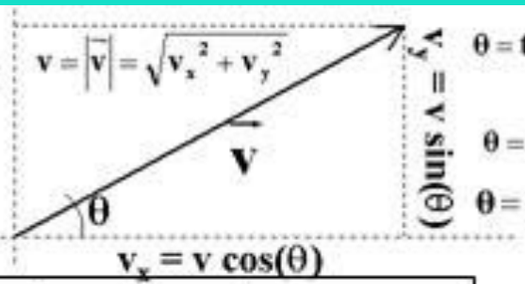


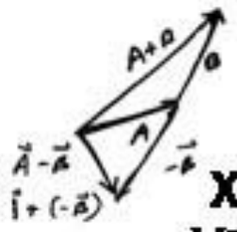
Phase Modulated Signal

Clarify the difference!

$$\Delta x = x_f - x_i \qquad \Delta v = v_f - v_i$$

$$\vec{v} = \frac{\Delta \vec{r}}{\Delta t} \qquad \vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$





$$\omega = \frac{\Delta\theta}{\Delta t} \qquad \alpha = \frac{\Delta\omega}{\Delta t}$$

$$x = r\theta \qquad \omega = 2\pi f \qquad f = \frac{1}{T}$$

$$v = \omega r$$

$$a = \alpha r \qquad \omega = \omega_o + \alpha t$$

$$I = \sum_i^{all} m_i r_i^2 \qquad \theta = \theta_o + \omega_o t + \frac{1}{2}\alpha t^2$$

$$\omega^2 - \omega_o^2 = 2\alpha(\theta - \theta_o)$$

$$L = r_\perp p = mvr_\perp \qquad \tau = r_\perp F = rF_\perp$$

$$L = I\omega \qquad \tau = \frac{\Delta L}{\Delta t} \qquad \tau = I\alpha$$

$$\frac{1}{2} I\omega^2$$

$$\sum_i^{all} \vec{F}_i = 0 \qquad \sum_i^{all} \vec{\tau}_i = 0$$

$$\Delta S \geq 0$$

$$\Delta Q = l\,\Delta(\text{quant.}) \qquad PV = nRT$$

$$e = \frac{\Delta W}{\Delta Q} \qquad e = 1 - \frac{T_L}{T_H} \qquad P = \frac{F}{A}$$

$$M = \rho V \qquad P_1 = P_2$$

$$\Delta P = \rho g\,\Delta h$$

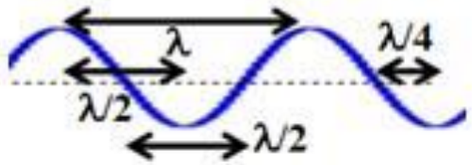
$$B = \rho_{liq} V_{disp} g$$

$$A_1 v_1 = A_2 v_2$$

$$P + \frac{1}{2}\rho v^2 = \text{const.}$$

$$v = \sqrt{\frac{T}{\rho}}$$

$$v = \lambda f$$



$$\frac{GM_e}{R_e} = gR_e \qquad \frac{GMm}{r^2}$$

$$-\frac{GMm}{r}$$

$$M_e = 5.97(10)^{24}\ \text{Kg}$$

$$R_e = 6.37(10)^6\ \text{m}$$

$$G = 6.67\,(10)^{-11}\ \text{N m}^2/\text{Kg}^2$$

$$v = v_o + at$$

$$x = x_o + v_o t + at^2/2$$

$$v^2 - v_o^2 = 2a(x - x_o)$$

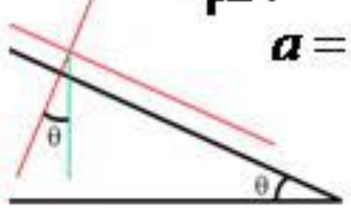
$$\bar{v} = \frac{v_f + v_i}{2} \qquad \Delta x = \bar{v}\,\Delta t$$

$$x \to x, y \qquad x_o \to x_o, y_o$$

$$v \to v_x, v_y \qquad v_o \to v_{ox}, v_{oy}$$

$$a \to a_x, a_y$$

$$\vec{F}_{tot} = m\vec{a}$$



$$\mu N \qquad a = \frac{v^2}{R}$$

$$E = K + U \qquad \Delta Q = (\text{quant.})\, C_{cond.}\, \Delta T$$

$$E_i = E_f \qquad \Delta Q_{into} = \Delta W_{by} + \Delta E$$

$$\frac{1}{2}mv^2 \qquad \frac{RT}{2}\Big|_{\text{deg. freedom}} \qquad C_P = C_V + R$$

$$W = F\,d_{\parallel} = F_{\parallel}\,d$$

$$W_{tot} = \Delta(KE)$$

$$\Delta U = -W_{if}$$

$$\frac{1}{2}kx^2 \qquad \omega = \sqrt{\frac{k}{m}}$$

$$p = mv$$

$$\vec{P}_{init} = \vec{P}_{final}$$

$$\left(\sum_j^{all} m_j \vec{v}_j\right)_{init} = \left(\sum_j^{all} m_j \vec{v}_j\right)_{final}$$

$$x = A\cos(\omega t) = \{\text{or}\}\ A\sin(\omega t)$$

$$v = -A\omega\sin(\omega t) = \{\text{or}\}\ A\omega\cos(\omega t)$$

$$a = -A\omega^2\cos(\omega t) = \{\text{or}\}\ -A\omega^2\sin(\omega t)$$

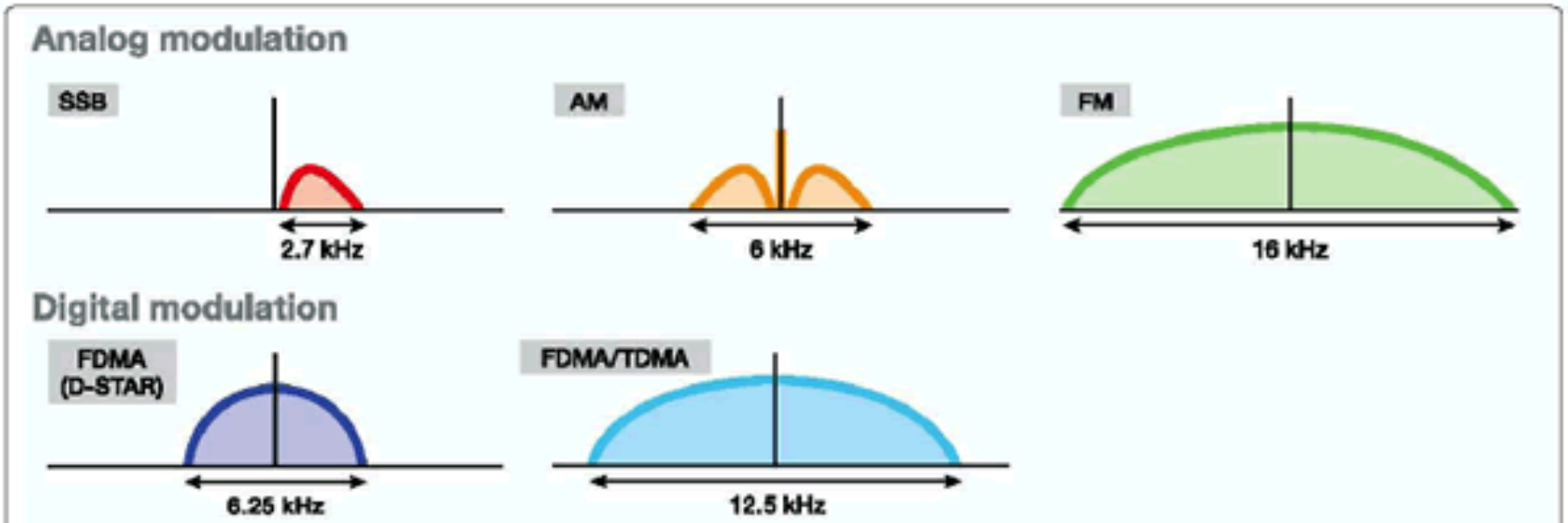


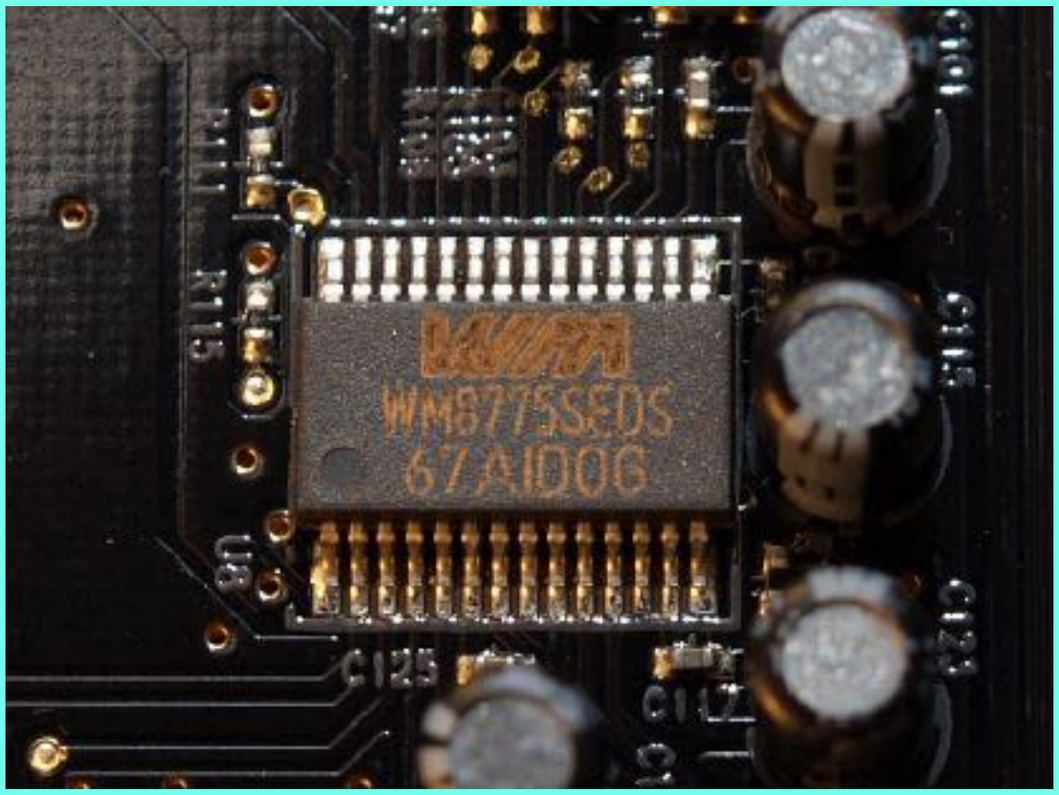
Fig. 8 Comparison of the occupied bandwidth

Digital Voice Modes

In all cases voice audio (analog) is

digitized by an A-to-D converter into a digital data stream,

and un-digitized back to analog audio by a D-to-A converter.



Overview of Digital Voice Modes

The digital data stream is processed in differing ways:

DSTAR: Used by Icom and Kenwood, MSK (aka: GMSK**)**
Packetized Minimum (frequency**) Shift Keying**
4800 Bits per second

FUSION: Used by Yaesu, C4FM
Compatible 4 Level FSK (Frequency Shift Keying)
Based on P25, a Motorola development
(Developed by ETSI (www.etsi.org**)**
9600 Bits per second
https://www.youtube.com/watch?v=Q6jgtPHOtqQ

DMR: Used by Tytera (TYT) and Motorola, TDMA
Time Division Multiple Access (time slots)
Developed by ETSI (www.etsi.org)
9600 effective bits per second

AMBE©:
Advanced
Multi-Band
Excitation

VOCODER:
Voice
Encoder
Decoder

Overview of Digital Links

DSTAR network uses gateway interfaces
at repeaters and reflectors
WX4EMA repeater in Macon
REF030B is well known in Georgia
DSTAR is worldwide, extensively installed

WIRES and WIRES-X by Brandmeister
for Yaesu Fusion
network of “rooms” like chat rooms

DMR uses MARC
Metropolitan Area Radio Council
worldwide network of “talk groups”

Echolink and IRLP and Allstar are analog remote control systems
(using VOIP)
Think of the repeater as a remote base controlled by one of the above.

Advantages and Disadvantages

Bandwidth and Throughput

DSTAR is narrow enough that it can be used in HF.

All three handle data/text while in voice mode.

Fusion has best audio quality (wider bandwidth).

DSTAR has most complete network, others growing.

DSTAR radio is most expensive, but that is changing.

DMR allows two users per channel … simultaneously.

Dongles for all … DVAP, DVDongle, DVMega, several others
Look at White Paper