

# Digital Voice Modes

30-Sep-2026

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# Digital Voice Modes

2m/1.25m/70cm/33cm/23cm

- DMR, P25, NXDN, TETRA, D-Star, YSF, M17
- {[https://en.wikipedia.org/wiki/Digital\\_mobile\\_radio](https://en.wikipedia.org/wiki/Digital_mobile_radio)}
- {[https://en.wikipedia.org/wiki/Project\\_25](https://en.wikipedia.org/wiki/Project_25)}
- {<https://en.wikipedia.org/wiki/NXDN>}
- {<https://en.wikipedia.org/wiki/TETRA>}
- {<https://en.wikipedia.org/wiki/D-STAR>}
- {[https://en.wikipedia.org/wiki/Yaesu\\_\(brand\)](https://en.wikipedia.org/wiki/Yaesu_(brand))}
- {[https://en.wikipedia.org/wiki/M17\\_\(amateur\\_radio\)](https://en.wikipedia.org/wiki/M17_(amateur_radio))}

# DMR(Digital Mobile Radio)

- Many Commercial & Amateur brands
- Most popular Amateur digital mode in the US
- Modulation: 4FSK
- Modulation Method: TDMA(2 slots)
- Data Rate: 4.8 kbps x 2
- Bandwidth: 12.5 KHz
- Vocoder: AMBE+2(DVSI)
- Usage: World Wide ETSI Commercial Standard
- Identification: Radio ID {<https://radioid.net/>}
- Voice quality: good
- Internet connectivity, talkgroups, reflectors
- hotspots
- CC equivalent of CTCSS

# P25 (Project 25)

- Many Commercial Brands
- Most popular Commercial Digital Mode
- Modulation: C4FM
- Modulation Method: FDMA
- Data Rate: 9.6kbps
- Bandwidth: 12.5 KHz
- Vocoder: AMBE+2(DVSI)
- Usage: public safety US, and others,
- Identification: Radio ID {<https://radioid.net/>}
- Voice quality: best
- internet connectivity, talkgroups, reflectors
- hotspots
- NAC equivalent of CTCSS

# NXDN

## (Next Generation Digital Narrowband)

- Icom(IDAS) + Kenwood(NexEdge)
- Commercial Standard
- Modulation: 4FSK
- Modulation Method: FDMA
- Data Rate: 4.8kbps
- Bandwidth: 6.25 KHz
- Vocoder: AMBE+2(DVSI)
- Usage: US and others(Railroads)
- Identification: Radio ID {<https://radioid.net/>}
- Voice quality: good
- hotspots
- RAN equivalent of CTCSS

# TETRA(Terrestrial Trunked Radio)

- Several brands(common in Europe)
- Commercial Public Safety Use in Europe(DMO + TMO)
- Modulation: FDD (full duplex)
- Modulation: Method TDMA(4 slots)
- Data Rate: 7.2 Kbps per slot
- Bandwidth: 25 KHz
- Vocoder: ACELP
- Identification: {<https://radioid.net/>}
- Voice quality: good
- hotspots\*(SDR )
- UHF only

# D-Star

## (Digital Smart Technologies for Amateur Radio)

- Icom + Kenwood (oldest amateur digital mode)
- Amateur Use Only(JARL) moderately active
- Modulation: GMSK
- Modulation Method: FDMA
- Data Rate: 4.8kbps(3.6 kbps voice, 1.2kbps data)
- Bandwidth: 6.25 KHz
- Vocoder: AMBE+(DVSI)
- Identification: callsign
- Voice quality: fair
- Internet connectivity reflectors & direct via callsign
- hotspots

# YSF(Yaesu System Fusion)

- Amateur Use Only(Yaesu) easiest to program
- Modulation: C4FM
- Modulation Method: FDMA
- Data Rate: 9.6 kbps
- Bandwidth: 12.5 khz
- Vocoder: AMBE(DVSI)
- Identification: callsign
- Voice quality: good
- Internet connectivity WIRES, Rooms
- hotspots

# M17

- Open source, community built
- Amateur Use Only, Connect Systems native support
- Modulation: 4FSK
- Modulation Method: FDMA
- Data Rate: 9600 bps
- Bandwidth: 12.5 KHz
- Codec 2 (open source)
- Users: MD-380, MD-390, & UV380 with mods
- Identification: callsign
- Voice quality: good
- Internet connectivity ?
- hotspots
- CAN equivalent of CTCSS

# Analog vs Digital

## Analog Transmission

- Microphone ->
  - Radio [pre-emphasis(ANALOG)-> modulator]
  - Transmission ~~(ANALOG)~~
  - Radio [demodulator-> de-emphasis(ANALOG)]
  - -> Speaker
- 
- Audio quality affected by pre-emphasis, modulator, analog path, demodulator, de-emphasis

## Digital Transmission

- Microphone ->
  - Radio [vocoder(DIGITAL)-> modulator]
  - Transmission ~~(DIGITAL)~~
  - Radio [demodulator(DIGITAL)->vocoder]
  - -> Speaker
- 
- Audio quality affected by vocoders only

# FM Analog Bandwidth

- 75 KHz deviation - FM broadcast
- 25 KHz deviation - Analog TV audio broadcast
- 15 KHz deviation - original wide band
- 5 KHz deviation - current wide band
- 2.5 KHz deviation - current narrow band

# HF

- FreeDV(Amateur only) <https://freedv.org/>
- Open Source, Codec2
- RADE(Radio Autoencoder)
- 1.6 khz bandwidth
- -2 dB SNR possible
- Reduced power like FT8, etc
- 7.1815 LSB Tuesday 2100 EST
- 14.236 USB calling frequency
- Built into some Flex Radios
- If you can do FT8, etc on your PC, you can do FreeDV

# HF

- Some ICOM radios support D-Star on HF
- M17 is being experimented with on HF also

# Radio Vendors

## Commercial

- EF Johnson, Harris, Hytera, Icom, Kenwood, Motorola, Tait, Vertex

## Amateur

- Icom, Kenwood, Yaesu, Connect Systems, Anytone, TYT, Alinco, Baofeng and others

# Where To Buy

- DMR - Amateur: Alinco, Anytone, Connect Systems, Hytera, TYT
- P25 – Commercial: Motorola, Kenwood, Tait, Harris
- NXDN – Commercial: Kenwood or Icom
- TETRA – Europe: Motorola, Supura, Hytera
- D-Star – Amateur: Icom or Kenwood
- YSF – Amateur: Yaesu

# Abbreviations

- GNSK - Gaussian Minimum Shift Keying
- 4FSK - 4 level Frequency Shift Keying
- C4FM - Continuous 4 level Frequency Modulation
- FDMA - Frequency Division Multiple Access
- TDMA - Time Division Multiple Access
- FDD - Frequency Division Duplex
  
- AMBE - Advanced Multi-Band Excitation
- IMBE - Improved Multi-Band Excitation
- ACELP - Algebraic Code-Excited Linear Prediction
- Codec2 - Open Source
  
- CC - Color Code equivalent to CTCSS
- NAC - Network Access Code equivalent to CTCSS
- RAN - equivalent to CTCSS
- CAN - equivalent to CTCSS
- CTCSS - Continuous Tone-Coded Squelch System

# References

- FreeDV - RADE - Radio Autoencoder
- D-Star - Digital Smart Technologies for Amateur Radio
- DVSI - Digital Voice Systems, Inc - Chelmsford MA
- JARL - Japanese Amateur Radio League
- ETSI - European Telecommunications Standards Institute
- APCO - Association of Public Safety Communications Officials

# The End

- If your head is still spinning, place one hand on each side of your head and gently apply pressure!