

Digital Communications

Zak Cohen, N6PK
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Advantages of Digital Communication

- Less bandwidth than voice on most protocols
- Less distortion
- Easier to design for various stages
- More reliable

Advantages of Digital Communication

- Low Power - 5 -30 watts is sufficient
- Many modes - choose your mode depending on conditions
- Works well under very poor conditions
- Emergency Communications – Use for lists

Advantages of Digital Communications

Because of digital signal processing, digital modes offer:

- Performance that cannot be achieved using voice (and in some cases even CW), through the use of reduced bandwidth
- PSK31 uses 100 hertz channels with 30 hertz signals
- Tens of QSOs in a 3Khz bandwidth versus one voice QSO
- Improved signal-to-noise performance (Reception below noise level)
- Some modes also offer built-in automatic error correction

Equipment

Digital Communications

Computer – Digital Device (Source)

With a internal or external sound card

Sound card – Provides sound from the computer software

Transceiver – Transmission Device

A Software program can control the transceiver

Equipment



Sound Card



Signalink SL-1+



Geeks.com \$5
USB audio-codec

Technology/Terms

- Modulation Techniques
 - Varying the analog carrier frequency to carry digital information
- Protocols
 - Formatting of the signal to allow devices to talk to each other
- Software
 - Set of instructions/programs used to operate computers to complete a task

Modulation Techniques

Digital Modulation Techniques

ASK – Amplitude Shift Keying

- Digital data is represented by variations in the amplitude of a carrier wave

FSK – Frequency Shift Keying

- Digital data is represented by discrete frequency changes of the carrier wave

PSK – Phase Shift Keying

- Digital data is represented by a phase shift of the output signal depending upon the input. Binary Phase Shift Keying *BPSK* and Quadrature Phase Shift Keying *QPSK*, are named according to the number of phase shifts. Differential Phase Shift Keying *DPSK* which changes the phase according to the previous value.

M-ary Encoding

- Two bits are transmitted simultaneously on a single signal – reduced bandwidth.

Amplitude Shift Keying - ASK

- On – Off Keying – CW/Morse Code
- Voltage Level Keying – RTTY at hardware levels
- Can be used with other shift keying to add bits (QAM) (M-Ary)
- Sensitive to atmospheric noise and propagation conditions

Frequency Shift Keying - FSK

Digital information is transmitted through discrete frequency changes of a carrier frequency

FSK – Modulate at RF frequency

AFSK – Audio FSK – frequency change at baseband

MFSK – Multiple frequency signal

Multi-frequency Shift Keying - MFSK

- Uses multiple frequencies to denote symbol change (2-64)
- Technique uses concurrent and/or sequential tones that implement this mode
- Forward Error correction – very robust
- Requires accurate tuning

Multi-frequency Shift Keying

Piccolo (Original MFSK - 1962)	FSK441
DTMF (AT&T – 2 Tone)	JT6M
MFSK8 / MFSK16	JT65
OLIVIA / Contestia / RTTYM	P14
THROB	
DominoF / DominoEX	

Phase Shift Keying - PSK

Phase Shift Keying is when digital information is transmitted through discrete phase changes of a carrier frequency

BPSK - Binary Phase Shift Keying

- Commonly called PSK [Sometimes 2-PSK]
- Relatively narrow bandwidth
- Good sensitivity to weak signals
- Use low power. **Can be overdriven!**
- Forward Error Correction is not used
- There is a variant called Quadrature Phase Shift Keying (QPSK) with error correction

Protocols

Protocols

Protocols are the formatting of the signal to allow devices to talk to each other

Examples:

- RTTY
- AX-25 (AMTOR, PACTOR, Packet)
- PSK-31, PSK63
- JT-65, JT-9
- FT-8, FT-4
- Hellischreiber, Olivia

Software

Software

The set of instructions/programs used to operate computers to complete a task

- Outpost for packet e-mail/applications
- RMS Express for Winlink
- Fldigi for various applications
- WSJT-X for weak signal software (FT-x and JT-x)

Mode AFSK - Protocol RTTY - S/W FLDIGI

- 1922 – Radio Teletype
- +5v is a logical 1 or mark, -5 v is a logical 0 or space(digital levels)
- +80v is a logical 0, -80v is a logical1 (Line Levels)
- Idle is Mark
- 5 Bit Baudot code
- Tones used are 2295/2125 Hz.
- 45 Baud

Mode AFSK - Protocol AX.25 - S/W Outpost

- AX.25 also used for Pactor/Winmor
- Uses old Bell 202 modem protocol for AX.25 and APRS (1980)
- 1200 bps
- 1200 Hz for mark (1) and 2200 Hz for space (0)

Mode AFSK - Protocol AMTOR - S/W

- Amateur Telex over radio (HF)
- 5 bit code – send 7 bits (4 marks/3 spaces) for error check
- Send 3 Character then error check
- 100 Baud – 400 HZ bandwidth
- Frequency shift of 170 Hz.

Mode FSK - Protocol Pactor - S/W Airmail

- Packet and AMTOR
- Needs a Terminal Node Controller
- 100 watts over long distances
- Can transfer data into the internet for communications
- Pactor-2 is a 2 tone PSK system

Mode PSK - Protocol PSK-31 - S/W FLDIGI

- Data rate close to typing rate – real time
- Low Power – narrow bandwidth
- Uses Varicode
- Symbol rate 31.25 Hz
- Needs Sound Card

Mode FSK - Protocol JT65 - S/W WSJT-X

- Started by design for Moon Bounce
- 180 Hz Bandwidth
- Limit 13 Characters per conversation over 50 sec
- Each side takes over 50 sec for each exchange
- One person sends one min the other the next minute

Mode FSK - Protocol JT9 - S/W WSJT-X

- Designed for LF, MF and HF bands
- Used for extreme weak signal conditions
- Vary narrow 9-FSK mode
- 16 Hz Bandwidth
- QSO lasts 5-6 min to transmit
- Not a rag-chew

Mode FSK - Protocol MT63 - S/W Fldigi

- Orthogonal Frequency Division Multiplexed mode.
- Highly redundant Forward Error Correction
- Handles interference and fading well
- Can be mistuned and still work [100 Hz]
- A bit wider than other modes
- Stations must use same interleave settings

Mode FSK - Protocol DominoEX - S/W

- Single carrier with 18 tone frequency with constant phases
- Very robust, no FEC
- Good weak signal LF and high speed HF use
- DominoEX 11 designed for NVIS (80m at night)
- Tolerant of tuning issues. [up to 200Hz. offset]
- keyboard to keyboard communications.

Mode FSK - Protocol FT-4 - S/W WSJT-X

- 6 sec sequences
- 4 tone frequency shift about 23.4 Baud
- Designed for 50% decoding probability at -16.4 but observed at -18 db or better
- Can work with signals 10 Db weaker than RTTY with less bandwidth

Mode FSK - Protocol FT-8 - S/W WSJT-X

- 8-frequency shift keying format
- Tones are spaced at 6.25 Hz, Signal occupies 50 Hz
- Transmit and receive cycles last about 152.65 Seconds
- 4x faster than JT65 or JT8
- Works well with EME where doppler shift would be a problem

Winlink Connection Modes

- There are four paths a user can connect to the Winlink system for amateur radio to the Internet
 - Via HF radio to one of the RMS hubs
 - Via VHF/UHF radio to a local RMS hub
 - Can use Outpost packet systems to send e-mails
 - Via Telenet protocol over the internet
 - Terminal emulation program that allows computer users to connect interactively to a server and access remote sites on the Internet
 - Via Winlink Webmail over the internet
 - Like using G-Mail
 - Need Winlink e-mail account: "ham call"@winlink.org

Now to the Demo –

N6PK to AG6AG ready?