Digital Modes 1

RTTY

Maui Amateur Radio Club

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Digital Modes

- Any modulation scheme that is read and generated by a machine.
- RTTY was the first.
- Now there are many
  - RTTY
  - PSK31, PSK63..
  - Olivia
  - JT65
  - MT63
  - ALE

History

- 1830’s – beginnings of telegraph, first in Europe then in US by Samuel Morse 1837
- 1840 – Wheatstone developed a system that did not require a skilled operator. A rotary dial with letters and numbers that the receiver recorded. Speed about 15 wpm.
- 1846 – House developed a system with a keyboard and printer, steam powered.
- 1855 – Hughes developed a printing telegraph system
- 1874 – Emile Baudot developed his 5 bit code that became standard
- 1901 – punch tape system in widespread use and the ‘modern’ teletype was in widespread use

Teletype machine with paper tape

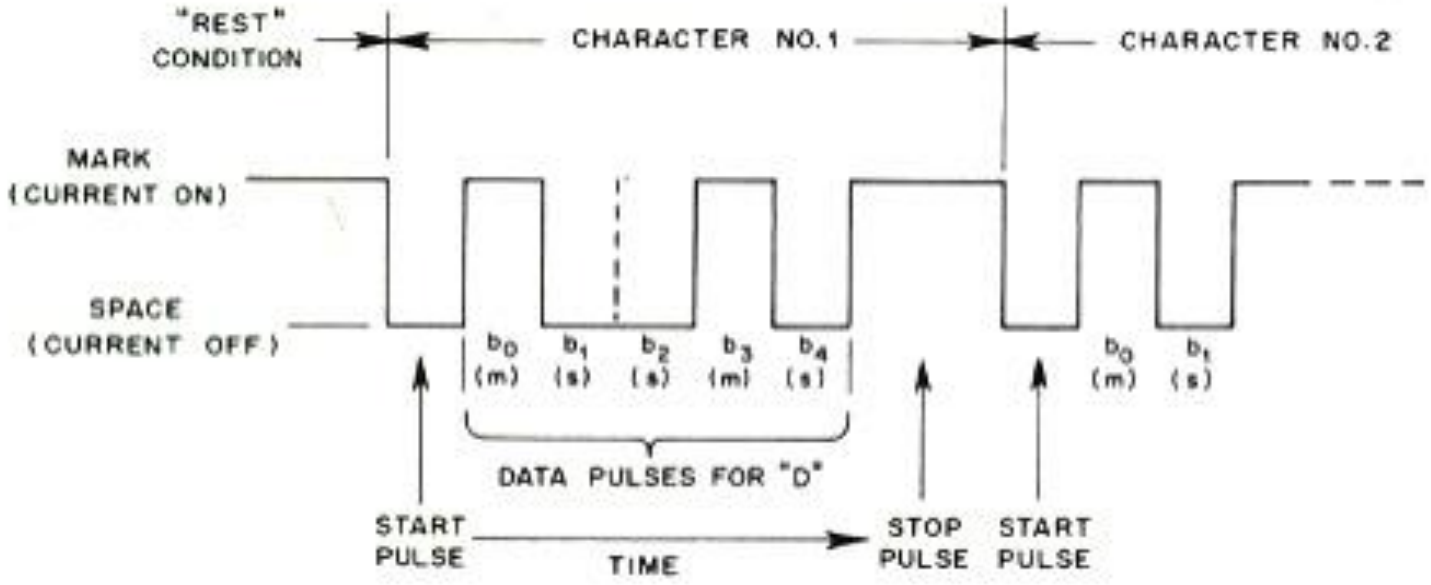
Baudot 5 bit Code

32 characters 26 letters plus
- Figure Shift
- Letter Shift
- Space
- Line Feed
- Carriage Return
- Blank

Letter	Figure	Bit: 4	3	2	1	0
A	—	1	1	0	0	0
B	?	1	0	0	1	1
C	:	0	1	1	1	0
D	$	1	0	0	1	0
E	3	1	0	0	0	0
F	!	1	0	1	1	0
G	&	0	1	0	1	1
H	#	0	0	1	0	1
I	8	0	1	1	0	0
J	'	1	1	0	1	0
K	(	1	1	1	1	0
L	)	0	1	0	0	1
M	.	0	0	1	1	1
N	,	0	0	1	1	0
O	9	0	0	0	1	1
P	0	0	1	1	0	1
Q	1	1	1	1	0	1
R	4	0	1	0	1	0
S	bel	1	0	1	0	0
T	5	0	0	0	0	1
U	7	1	1	1	0	0
V	;	0	1	1	1	1
W	2	1	1	0	0	1
X	/	1	0	1	1	1
Y	6	1	0	1	0	1
Z	"	1	0	0	0	1
Figure shift		1	1	1	1	1
Letter shift		1	1	0	1	1
Space		0	0	1	0	0
Line feed (LF)		0	1	0	0	0
Blank (null)		0	0	0	0	0

Asynchronous data transmission

Gave birth to many serial communication protocols – RS-232, RS-422, IIC, and USB

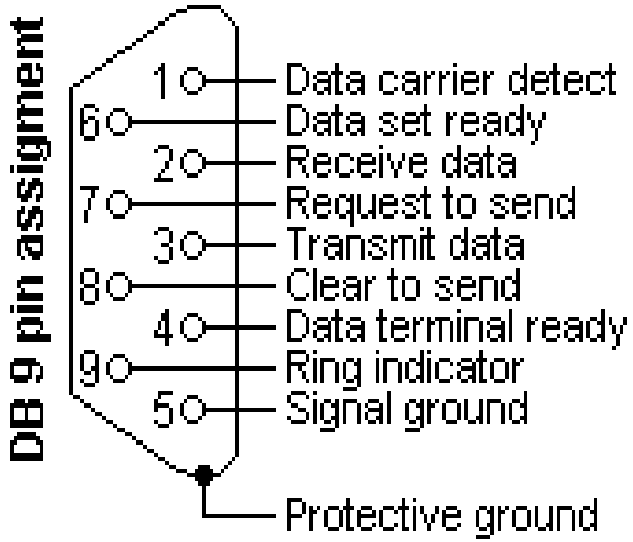


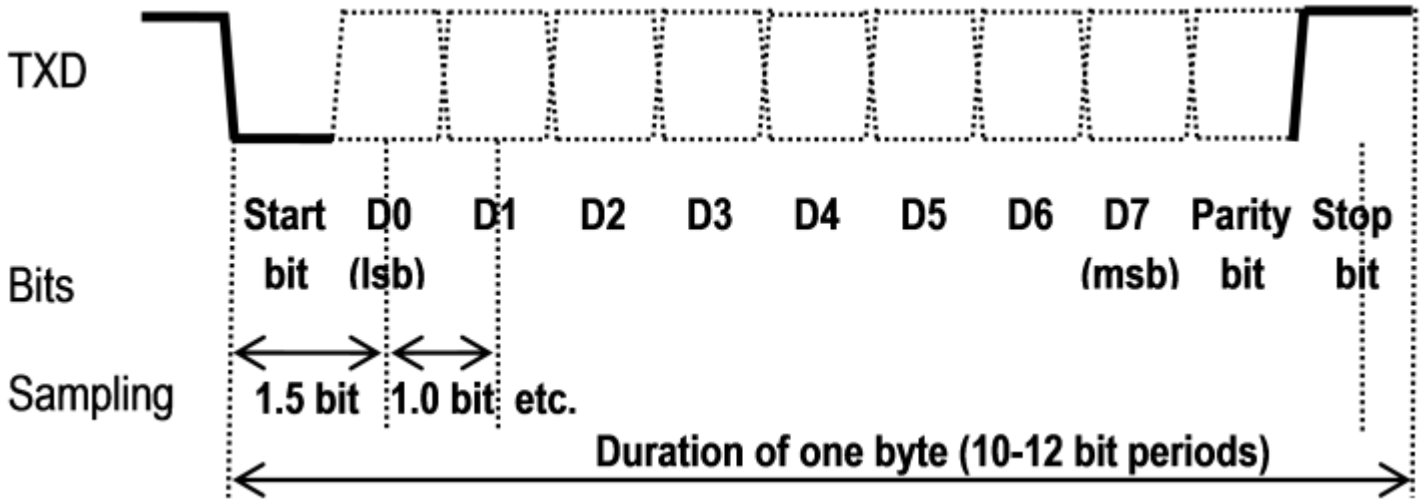
The speed and the maximum number of bits in a word are limited by:

Noise
Clock stability
Clock jitter

Originally Mark was +80 Volts, Space was -80 Volts
RS-232 standard is +8V for Mark (3 / 15) and -8V for Space (-3 / -15)

RS-232 serial ports





Need to set:

- Baud
- Number of Bits in the word
- Number of Stop Bits
- Handshaking line status
- ~~Parity~~

ASR-33 Teletype machine, circa 1963

10 Characters/Sec
110 Baud
7 bit ASCII Coding
One Start Bit
7 Data Bits
1 Parity Bit
2 Stop Bits

Used a synchronous motor rotating disk and brushes to generate and receive the data

Paper punch tape for data storage and transfer

RTTY

- 1922 – US Navy developed a system for air to ground communication.
- By the end of WWII, RTTY was the dominate method for long distance communication.
- After the war, hams got surplus equipment and adapted it for amateur use.
- 1953 – the FCC standardized amateur use at ‘speed 60’ and a 5 bit code using FSK (frequency shift keying). Also required CW id every 10 minutes. Originally the shift was 850 Hz but hams found that for HF a smaller shift worked better and settled on 170 Hz.

Modern RTTY

- ‘Speed 60’ = 45.45 Baud FSK (frequency shift coding)
  - About 60 words/minute
- 5 bit Baudot coding, each bit is 22 msec long
  - All upper case, needs a special shift characters to get numbers
  - Most hams operate UNOS (unshift on space)
- 170 Hz frequency shift
- Traditional to operate in SSB/LSB mode.
  - Mark = 2.125 kHz below the carrier frequency
  - Space = 2.295 kHz below the carrier frequency
- Use a sound card for decoding.

Radio – Interface - Computer

Everybody uses a sound card for decoding the SSB audio output

Don’t need separate interface, can go directly into soundcard
Microphone and earphone connectors

Need to handle PTT function somehow

Two ways to generate output

Soundcard – the sound card generates the two audio frequencies and drive the microphone/data input of the radio

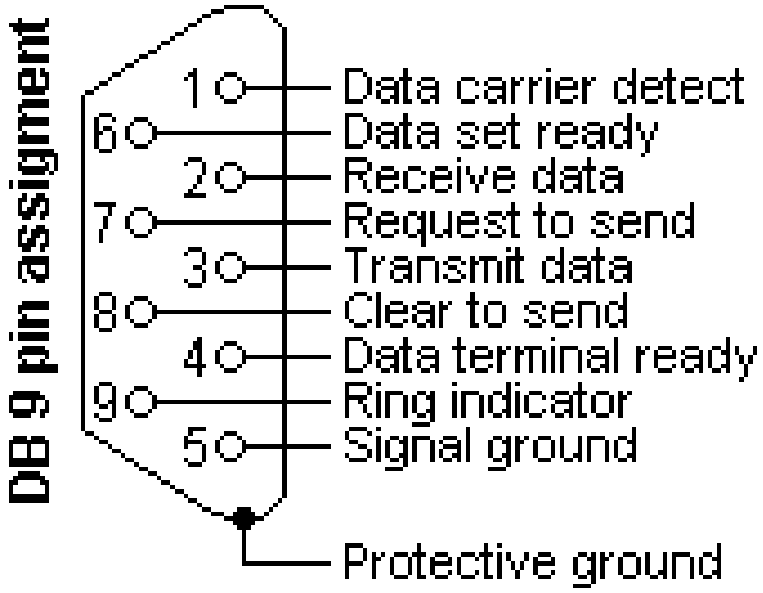
Native FSK mode

computer generates a binary stream that tells the radio to shift between two frequencies (Radio is running CW alternating between two different frequencies)

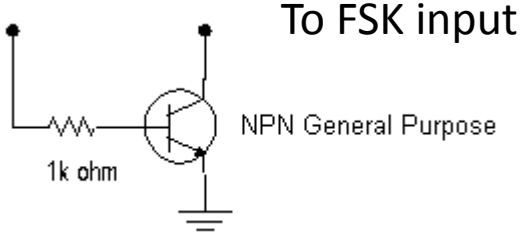
Many Radio have dedicated RTTY/FSK input

- Much better way to operate
- Binary input shifts CW between two frequencies – MARK – SPACE
- No worries about overdriving the SSB audio stages and ending up with a distorted signal
- Many radio have special filter setups for RTTY
- Some have native decoding
- Easier logging, the mode is set and the frequency is correct
- Requires a simple interface between USB/RS-232 interface and radio

Simple RTTY interface



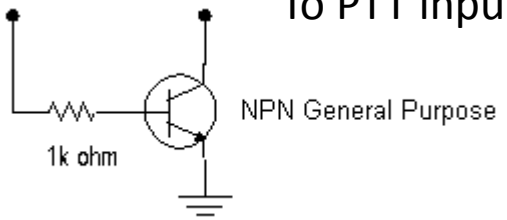
TxD
Pin 3



To FSK input of Radio

2N2222

RTS
Pin 7



To PTT input of Radio

You can get all the parts at Radio Shack

Be careful RTTY is a 100% duty cycle mode

Software

- MMTTY
- Fldigi
- Ham Radio Deluxe
- N1MM Logging
  - Uses a combination of MMTTY and Fldigi for RTTY (or other digital modes)

It can be hard, tricky, and finicky to get set up but it is easy and un-stressfull to operate

Operation

- Lots of errors in decoding, no error detection. You need to learn what to look for.
- All upper case, no punctuation, few numbers
- Keep transmissions short to avoid overheating
- Seems to mostly be used for contesting and Dxing
- Works very well in poor conditions, especially since you can run QRO

Typical Contest Exchange

CQ CQ CQ FD DE KH6RS KH6RS KH6RS K

DE W1AW W1AW W1AW K

W1AW 3A PAC 3A PAC W1AW

QSL 1D CT 1D CT W1AW TU

W1AW TU DE KH6RS QRZ

Typical Dxpedition Exchange

CQ CQ CQ DE W1AW/KH6 W1AW/KH6 UP 1 – 2

DE K1TCH K1TCH K1TCH K

K1TCH 599 HI K1TCH

QSL UR 599 MA K1TCH TU

K1TCH TU DE W1AW/KH6 QRZ UP 1 - 2