JT-9 and WSJT-X

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Joe Taylor –K1JT on left

Joe Taylor is a Nobel prize winning professor of physics who has retired from Princeton.

Joe has created many new amateur radio modes including;

WSPR - one way transmission. Web program to look at who has received you.

JT-65 – created for moon bounce EME. Found to be useful on HF.

JT-9 – created later for HF.

MSK144- meteor scatter – vhf+

JT-4 – EME vhf+ mode

Joe Taylor modes - common attributes

- 1. Precise time windows and transmit only in your time window
- 2. Fixed exchanges – not very conversational
- 3. Forward error correction – not NAK and retransmit
- 4. Work below the noise floor – substantially below
- 5. Full duty cycle while transmitting
- 6. Effective with low power and a compromise antenna
- 7. Very slow data rate – less than 2 baud

SAMPLE JT65/JT9 QSO

CQ DE SM7VRZ JO76	I transmitt CQ including my locator grid.
SM7VRZ DE TE5ST JO99	I receive an answer from the remote station including his locator grid.
TE5ST DE SM7VRZ +05	I transmitt the remote stations signal report.
SM7VRZ DE TE5ST R -01	The remote station acknowledge the report and transmitts my signal report.
TE5ST DE SM7VRZ RRR	I acknowledge the report.
SM7VRZ DE TE5ST 73	The remote station terminates the QSO with 73.
TE5ST DE SM7VRZ 73	I terminate the QSO with 73.

JT-9 VS JT-65

- 1. Both transmit max of 13 characters per time window
- 2. Both have signal report generated by decoder
- 3. Bandwith – JT-9 15HZ – JT-65 177HZ. So JT-9 takes less than 10% of the bandwith of JT-65
- 4. JT-9 has 2 db better sensitivity at -27 db S/N vs. -25 db S/N for JT-65
- 5. Modulation – JT-9 uses 9 tones. They are sent at 85 intervals during the 48 second xmit window for a baud rate of 1.7. JT-65 uses 65 tones for a baud rate of 2.6. Both use less bits than CW would need to send same message.

QST compares JT-65 sensitivity to CW

Table 2
Average Receiver Sensitivities

Mode	Receiver Sensitivity (microvolts)	Receiver Sensitivity (dBm)	Compared to CW (dB)
AM	0.72	–109.9	–25.1
SSB	0.22	–120.3	–14.7
FM	0.29	–117.7	–17.3
RTTY	0.096	–127.3	–7.7
CW	0.040	–135.0	ref: 0
PSK31	0.023	–139.8	+4.8
JT65	0.0035	–156.2	+21.2

What We Mean by "Receiver Sensitivity"

Consistent comparisons of receivers and modulation modes require us to apply a consistent standard definition of sensitivity. For voice modes we chose 12 dB SINAD for FM and 10 dB (S+N)/N for AM, straight out of the ARRL product reviews. For SSB we adopted 10 dB above the minimum detectable signal (MDS) measured in the SSB bandwidth, adjusted from the ARRL Lab measured MDS in a 500 Hz bandwidth. Thus, all of the measurements can be traced to ARRL Lab product review tests and test procedures.[A]

For CW and conversational digital modes like RTTY, and PSK31, we defined sensitivity as the signal level needed to decode a random five-character group ("PARIS_") with a 95% reliability. For CW that level is 9.2 dB above MDS in a 100 Hz bandwidth using theory for on-off keying. A 100 Hz bandwidth corresponds to the ERB (effective rectangular bandwidth) of the ear for a 700 Hz CW side tone frequency.[B] Yes, the human

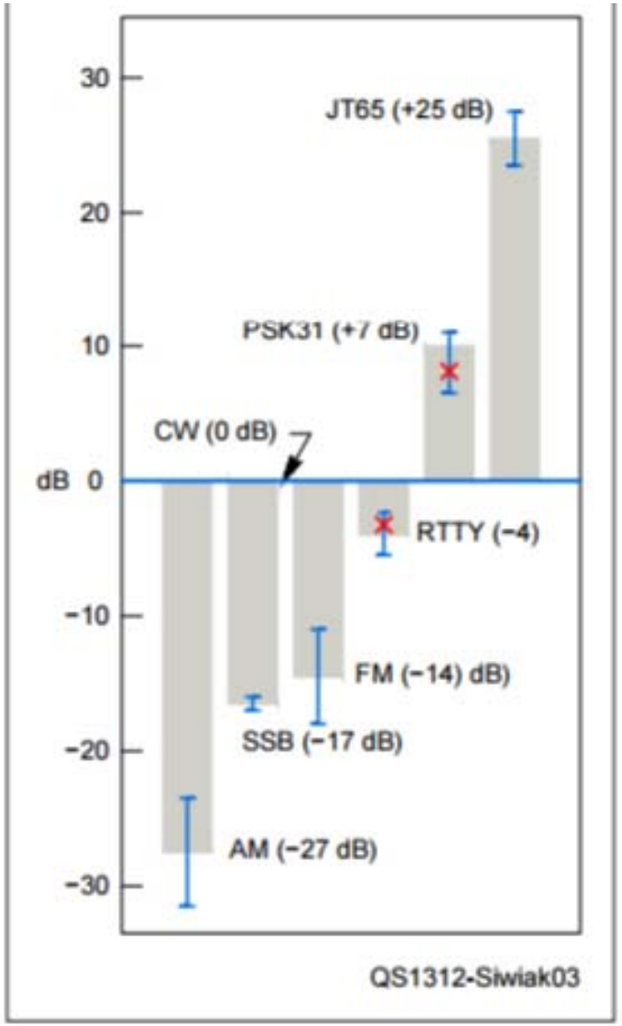


Figure 3 – Comparison of ham radio modes relative to CW

QST – distance of modes compared

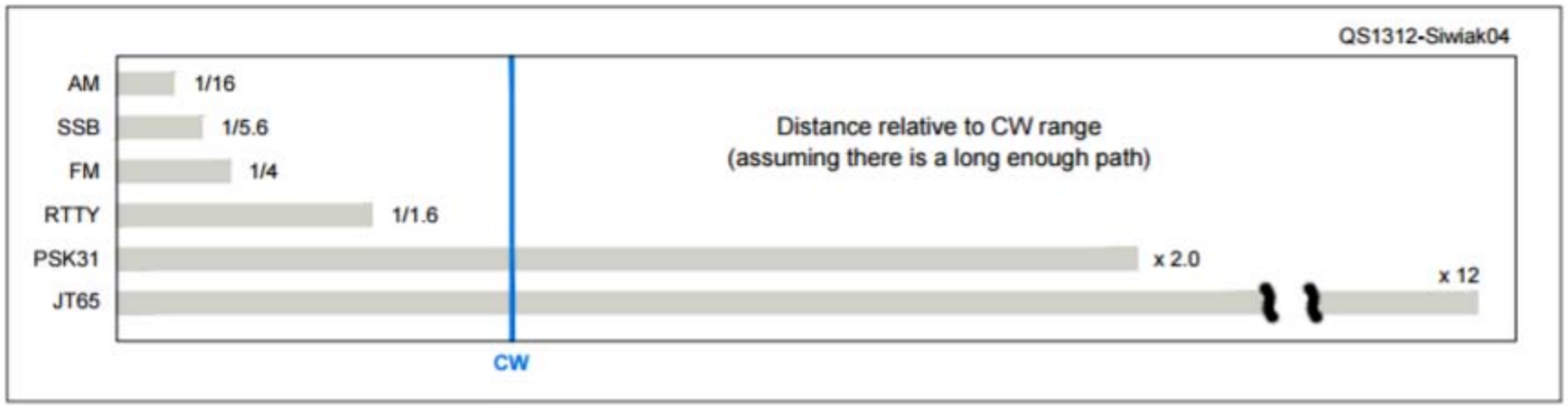


Figure 4 – Relative range of different modes for a radio path link.

Table 3
Occupied Bandwidth and Noise Bandwidth

Mode	Noise Bandwidth, Hz	Occupied Bandwidth, Hz	Emission Designator
AM	6000	6000	6K00 A3E
SSB	2456	2500	2K50 J3E
FM	12,500	12,500	12K5 F3E
RTTY	180	250	250H F1B
CW	100	100	100H A1A
PSK31	31.25	62.5	62H5 G1B
JT65	2.692	175	175H F7B

(Reunion Island) on two bands using JT65. If you need that rare one in your logbook, concentrate on CW, then on RTTY, and finally SSB *in that order*. Using this strategy the authors have increased their DXCC totals using every mode except AM or FM.

In Conclusion

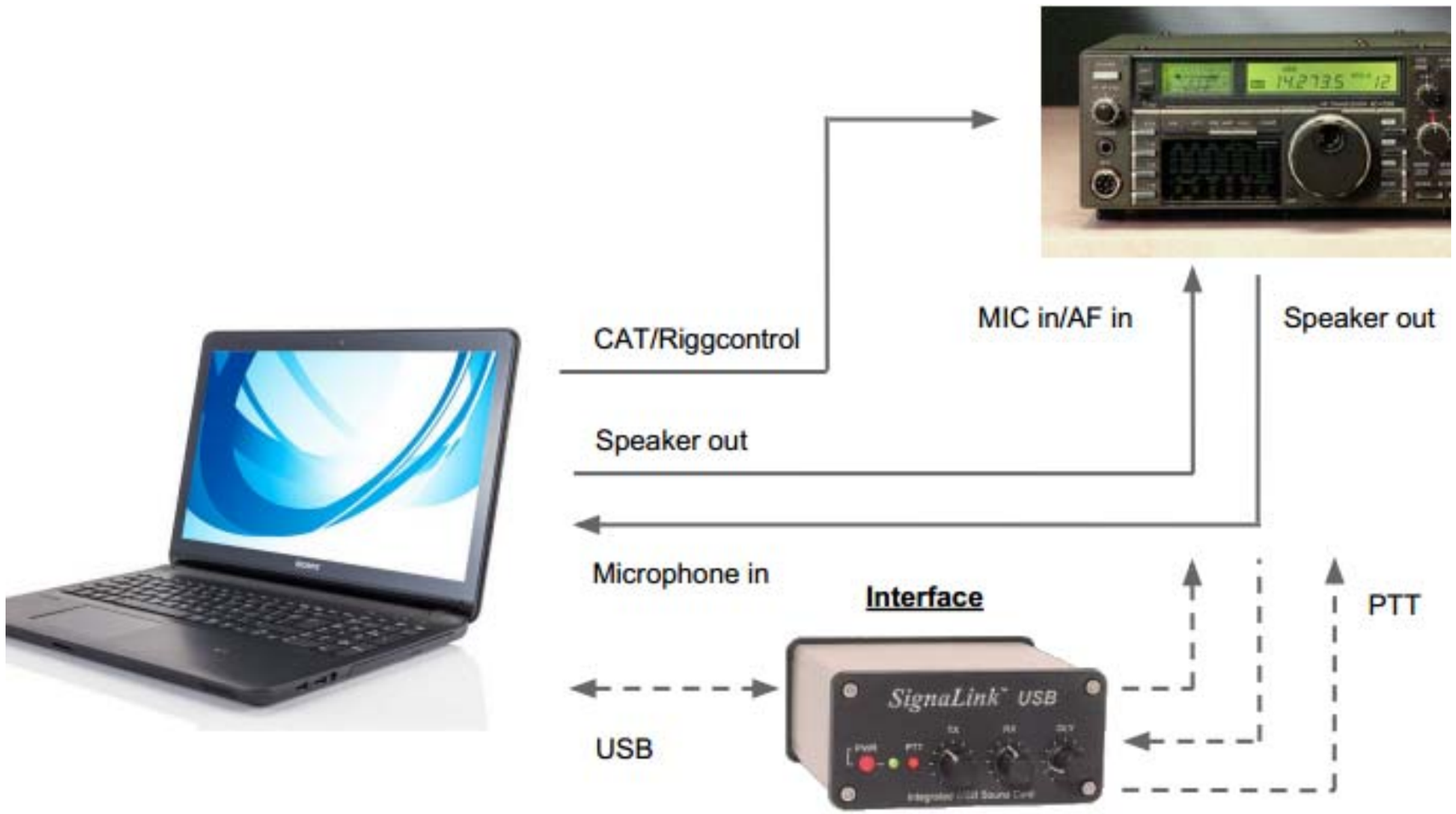
In this simple comparison we considered "Additive White Gaussian Noise" (AWGN) as the only impairment in the radio link.

JT-9 Submodes – trading time for sensitivity and bandwidth

Submode	Tone duration (sek)	Signal bandwidth (Hz)	S/N threshold (dB)*	Comunication duration (minutes)
JT9-1	0,58	15	-27	6
JT9-2	1,28	7	-30	12
JT9-5	3,41	2,6	-34	30
JT9-10	6,91	1,3	-37	60
JT9-30	21,00	0,4	-42	180

* *Noise measured in 2500Hz passband*

Equipment set up for JT-9 and most digital modes



References

- Description of JT-65 protocol
  http://physics.princeton.edu/pulsar/K1JT/JT65.pdf
- Software WSJT-X (windows, linux, Mac)
  Https://physics.princeton.edu/pulsar/k1jt/wsjtx.html
- JTAlertX – set alerts on state, dxcc entites and cq zones you need.