

Technical data of the high-speed modem

The theoretical limit of 9340 bps at a given bandwidth and S/N may have to be corrected to take into account the limited capabilities of the hardware used, especially the transceiver. For example, ICOM transceivers in DATA mode have a fixed Tx bandwidth of 2400 Hz. This results in a maximum bit rate of 8300 bps for an S/N = 10dB. Older transceivers have different bandwidths. Especially near the filter edges the linearity and phase response start to drop off, which is why an additional reserve distance is necessary (excess bandwidth). Further adjustments to the filter curve are made with a digital equalizer. An attempt was made to determine the achievable limits for QPSK and 8APSK modulation by measurements with several different transceivers.

This project is still very young. Especially the modulation procedures will surely be followed by some more steps. For a stable starting point, two modulation types were initially implemented:

- QPSK with a bit rate from 3000 bps to 4800 bps (nominal 4410 bps)
- 8APSK with a bit rate from 5500 bps to 7200 bps (nominally 6000 bps when using an ICOM IC-9700 or 7200 bps when using an SDR such as Pluto or LimeSDR)
- Error correction: Reed Solomon Code [3]
- Full duplex (reception of own transmission possible, important on QO-100)
- Full duplex QSOs in split operation
- Transmission of any data such as images, text, HTML pages, entire web presences, binary data
- Transmission of file names and file size as well as CRC secured transfer of files via QO-100
- Automatic scaling of images according to the desired transmission time
- Automatic ZIP compression
- Digital voice transmission using CODEC-2 or OPUS

Initial tests have been conducted by DJØABR, DH5RAE, DL1EV and DL3MX. Alfred, DL3MX, had set up a very small system with a 40 cm parabolic dish on a tripod. The following results were achieved:

Operating mode	0-error SNR	0-error power	Minimum SNR	Minimum performance
QPSK-4410	+13dB	500mW	+11dB	300mW
8APSK-6000	+19dB	1,25W	+17dB	800mW

The performance data refer to a transmitter which reaches beacon levels at 5 W in SSB mode. In these measurements, the average BPSK-400 beacon was received with an SNR of approx. +25 dB (fluctuating between +24 to +28 dB). Since an error rate of (almost) 0 is already achieved with very small dishes, procedures involving the request of new data blocks are deemed to not be necessary. In case of an error, images are simply sent again, which is no problem with short transmission times of 10 to 30 seconds.

In further work to improve data rate and SNR, attention must always be paid to the widest possible range of use with a large number of radios.

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