

Digital voice transmission: the AOR ARD9800

Back in 1999, Andy Talbot, G4JNT, and Charles Brain, G4GUO, were experimenting with digital voice transmission over a 70km path on 40m SSB. An article [1] was published in *RadCom*, a paper presented at the 18th ARRL/TAPR Digital Communications Conference, and another article in the May / June 2000 edition of the US-based experimenters' journal *QEX*, yet their digital voice modem remained an experimental, and definitely entirely home-made, piece of hardware. The hardware-based modem gave excellent FM-quality voice over an SSB mode and bandwidth, using a digital vocoder and DQPSK modulation with 36 tone carriers spaced at 62.5Hz, with an overall bandwidth of 312.5Hz to 2500Hz. This allows the system to be used in a standard SSB bandwidth, as well on other modes such as AM and FM (a comprehensive technical description is on G4GUO's website - see 'Web search').

The Japanese company of AOR has now 'grabbed the bull by the horns' and turned Charles's and Andy's ideas into a commercially-available piece of hardware, the ARD9800 digital communications modem.

SELF-CONTAINED

The ARD9800 is a stand-alone unit, which simply connects to the microphone input and speaker output connections of a transceiver and a suitable 12V DC supply. It measures 100 x 32 x 158mm, weighs around 600g, and comes supplied with plug-in speaker-microphone, DC supply lead, PC interface cable, speaker cable, an eight-pin plug matching the 'radio' connector at the rear of the unit, and a user instruction manual. Apart from the radio termination, for which you'll have to make up a lead to suit your transceiver, the rest is almost a simple 'plug in and go' operation. If you're not skilled with a soldering iron, ready-made leads to suit a variety of radios are available, as AOR have chosen the standard 'Adonis' microphone connection pin arrangement for their 'radio' interface connector.

So, after I'd made up a lead to

match my HF transceiver, I was ready to put it on the air. This was a simple exercise of first adjusting the receive audio volume level on my transceiver so that the 'Over' LED on the modem's front panel just extinguished, and secondly adjusting the mic gain on my transceiver to suit the modem's transmit output level. There's a pre-set level adjustment on the modem for this, accessible using a small screwdriver via a hole in the lower case lid, but I found I didn't need to adjust it. The receive audio is usually routed to a small speaker on the top case lid of the modem, the speaker-mic can also be used for this. A 3.5mm external speaker jack socket is also fitted on the rear panel. I used this with my external desktop speaker on receive as the modem's small internal speaker was, fairly naturally, a little 'tinny' sounding.

OPERATION



With the modem's front-panel analogue / digital switch set to the analogue (~) position, conventional SSB operation is available. To use digital voice, you simply set the switch to the digital ('10101') position and incoming digital audio is automatically decoded (non-digital audio is simply routed straight through).

On receive, the speaker volume is adjusted by using a small rotary volume control on the modem's front panel - it's important to keep your main receiver volume unaltered once it's been set to the right level for the modem.



On transmit, the first second of each transmission is taken up by a synchronisation header, during which the 'BUS' LED on the modem's front panel flashes. After this, it lights steady red to show you're in digital speech transmit mode. This is important, in that you need to wait at least a second after pressing the PTT before you start speaking otherwise the first part of your transmission will be lost. Unlike normal SSB, where the average power is usually much less than the PEP, in digital mode the transceiver is being run in virtually 'constant carrier' mode, ie 100% duty cycle just like RTTY or PSK31. Remember this if you're using a linear amplifier!

DATA

You can also send and receive data with the modem at an impressive over-air 3600 bits/sec rate, using a terminal program such as Windows HyperTerminal. Both ASCII data or binary data (eg for file transmission) can be used, and both types can be mixed as communication data. However, you need to be careful with certain data 'strings', as the hexadecimal [FE] command is used to signify the start and end of each data stream - you'll need to use a conversion if [FE] appears in the middle of your data stream. At the receive end, the data is automatically decoded by the modem, and displayed by the other station's terminal program.

DIGITAL IMAGE COMMUNICATION

Within the modem is a plug-in slot for an optional memory module. If

It seems like the whole world of wireless communications has either gone, or is going, fully digital. That is, apart from radio amateurs using speech on SSB or FM. But that may not be for too long, as Chris Lorek reports...

Fast Data Modem

this is fitted, you can also send and receive TV-resolution digital video frames. Just connect a video input, eg a standard PAL TV camera, to the relevant socket on the rear panel, and press the 'TX' push button on the front of the modem. This will 'grab' a frame of video and send it over the air, using JPEG compression. A typical frame will take around a couple of minutes to be transmitted. US versions come with NTSC video, so note that trans-Atlantic video contacts may not be compatible unless you've the appropriate image-conversion system at your station (eg most domestic video recorders can replay PAL and NTSC video). A video output phono socket connects to your video monitor for playback and monitoring.

SELECTIVE CALLING

If you wish, using the PC interface you can program a 'digital squelch' into the modem. Here, you can assign your own five-digit identification number, and specify the ID numbers for your destination stations. The ARD9800 I tested was also equipped with an IDENT and NET-MASK facility. This allows the digital squelch to remain muted until you are called by a member of your own group or groups, with 16 selectable addresses and scenarios. I simply kept this at the default of '00000' for all, although communicating with others who have pre-programmed other IDs was quite satisfactory as long as they'd not programmed the

NETMASK/ID decode as activated.

The ARD9800 uses a published 'open' protocol of data communications, so this is fine by most regulatory bodies including the UK's Ofcom and the US's FCC for over-the-air amateur use. An obvious question is of course whether it could be used commercially and, yes, there's a professional version, the ARD9900, which adds selectively switched data encryption for over-air communications security.

ON-AIR RESULTS



In normal use on receive, whether digital mode is selected or not, as soon as the unit detects a valid digital audio code it automatically switches to receive digital mode. With the help of RSGB Spectrum Forum Chairman and HF Manager Colin Thomas, G3PSM, using a similarly-equipped station, we conducted a number of tests on various bands, times and antenna systems to replicate various operating paths and associated signal strengths.

Our initial findings on weak but copyable SSB paths were, to be honest, a little disappointing. Sometimes the unit would try to decode, other times it wouldn't, other times we just got very garbled audio. But as soon as we chose a path giving '59 copy' the results were astonishing! Absolutely 'telephone quality' speech was the result - you really could not believe this was HF SSB! A digital Automatic Frequency Control (AFC)

of $\pm 125\text{Hz}$ is built in, so you don't have to be spot on frequency, likewise if one station changes frequency slightly in mid-contact you'll still remain 'locked in'.

All in all, if there was a good path available for reasonable quality SSB, above around 15dB signal-to-noise ratio (ie R5 copy) from my on-air test results I found the units would synchronise and work very well. Below this, a trained ear would still be able to read the SSB along with various pops, crackles and other interference to at least some degree, whereas the ARD9800 wouldn't be able to cope. Admittedly, unlike weak-signal text-based data modes such as PSK31 and PacTOR, G4JNT and G4GUO certainly didn't claim this to be a weak-signal mode, saying it requires "about a 25dB SNR to function", which I'd go along with.

The ARD9800 is currently available in the UK and USA, and besides these countries you'll also find users to my knowledge in Cyprus (5B4AFQ), Denmark (OZ1DX, OZ1UL, OZ1UM, OZ1YA, OZ2FF, OZ4PY, OZ6TX and OZ7JP), and the Philippines (DU1EOV).

I wasn't able to test the modem over a wide variety of selective-fading and multi-path selective fading propagation scenarios, mainly due to the lack of many others using the system at the moment. However, over the mixed ground wave and NVIS sky-wave paths I tried the unit on, it did perform admirably as long as a reasonable signal-to-noise ratio was there. The modem has an inherent 4mS 'guard interval' together with Forward Error Correction (FEC) to help against this, which did seem to work well. It also appeared to be able to get through constant-carrier and switched-carrier (eg CW) interference, probably due to the 36 different tone frequencies used together with the FEC.

Although each transmission gives a digital preamble, if the data synchronisation fails, either at this point or in mid-transmission due to QRM, I found that (as the instruction manual suggests) manually switching over to 'analogue' mode and then



pressing and holding the front-panel 'TX' button would often give a gradual but successful decode of the incoming digital audio.

"CQ DIGITAL"

As digital voice on HF is currently in its infancy, unless you've pre-arranged a sked you'll probably find it a 'hit-and-miss' affair to get contacts! There's a suggested calling frequency of 18162.5kHz for this, although an initial call in normal USB of "CQ Digital" would probably not go amiss. Unlike some other countries such as the US, where callsign identification is OK in the mode being transmitted, here in the UK you'll need to identify your callsign at least every 15 minutes in a traditional analogue mode. This means, during 'ragchews' and the like, switching back to normal SSB and giving an analogue SSB (or CW) speech identification every so often. I'd have preferred an optional 'auto-CW' ID to have been included, as present in many packet and multi-mode terminal units, but this is just a minor point.

I did confuse a few amateurs on my local 2m and 70cm repeaters when I had contacts through these using the modem! The upshot of this, though, was that they became interested in the system, and are awaiting the day when either hardware prices come down or PC-based



soundcard software becomes available for the mode. Although I didn't test the modem in VHF/UHF FM mobile operation, AOR says this could result in periodic losses of data synchronisation due to mobile 'fast-flutter' signal fades.

THE FUTURE

Around 20 years ago I purchased a multi-mode radio data modem, for around the same price in today's terms as the ARD9800, and I haven't looked back nor ever regretted the decision. Likewise a few years later with a DSP filter unit which I built myself, as no commercial versions were available at the time. Since then other options, such as PC sound-card based software, have eventually become available for some of these modes, and as time marches on, so does technology and

processor speeds. It could be a while before PC processors become fast enough to handle this digital speech mode via a sound card, but as history has proven, hardware-based solutions lead.

We already have commercial 'off-the-shelf' HF transceivers available with built-in RTTY and PSK31 data capabilities - just plug in a keyboard and off you go. Is it just a short matter of time until amateur radio equipment manufacturers add a further 'digital modulation' push-button to the front panel of their transceivers?

I feel AOR are to be commended in leading the field by launching a ready to use add-on set-top box which instantly transforms any amateur radio transceiver into a digital multimedia (speech, data, and video) transceiver.

Our thanks go to AOR (UK) for the loan of the pair of ARD9800 modems for review. The ARD9800 is available from all authorised AOR (UK) dealers at a current retail price of £499. ♦

REFERENCES

[1] 'Digital Voice Communication', by Andy Talbot, G4JNT, RadCom October / November 1999.

WEB SEARCH

Charles Brain, G4GUO (G4GUO / G4JNT digital voice modem 1999)
www.chbrain.dircon.co.uk/dvhf.html

AOR (UK)
www.aoruk.com

WIN! A bhi 'Wonder Wand' HF - UHF portable antenna system and tuneable counterpoise system

A bhi Wonder Wand HF - UHF portable antenna system and tuneable counterpoise system can be won in our exclusive competition, courtesy of bhi Ltd



The bhi Wonder Wand HF - UHF portable antenna was reviewed by Chris Lorek, G4HCL, in last month's RadCom (see June 2004 RadCom page 29). Chris concluded that the Wonder Wand gave around the same performance as a car-mounted mobile whip of about the same length. Absolutely ideal for portable operation in the summer while sitting in the garden or in a pub beer garden, the Wonder Wand allows you to operate on the HF to UHF bands from virtually anywhere.

The prizes in our competition are a bhi Wonder Wand portable antenna and the matching tuneable counterpoise system. Since the review was published, bhi has informed us that it has reduced the price of the Wonder Wand. It now costs £89.95.

The tuned counterpoise system is £59.95 and there is a 'W Wand Offer' of the two items together for £139.90.

The full rules are listed below. (Hint: re-reading Chris Lorek's review in the June 2004 RadCom will help you with the answers!)

COMPETITION RULES

Look at the three multiple choice questions below. Write your answers on a postcard or the back of a sealed envelope (no letters accepted) and send to: 'Wonder Wand' Competition, RSGB, Lambda House, Cranborne Road, Potters Bar, Herts EN6 3JE. Entries must be received at RSGB HQ by first post on Monday 2 August. You must be a current member of the RSGB on the closing date of the competition (2/8/04) in order to enter. The winner will be announced in the September RadCom.

Q1. The bhi 'Wonder Wand' operates on which bands?

(a) 7 - 50MHz bands (b) 7 - 144MHz bands (c) 7 - 430MHz bands.

Q2. To what length should the telescopic whip be adjusted for operation on 7 to 28MHz?

(a) 33cm (b) 1.0m (c) 113.5cm.

Q3. Where is the 'Wonder Wand' made?

(a) Japan (b) Great Britain (c) USA.

THE SMALL PRINT

Only one entry per member (multiple entries will be disqualified). No other correspondence can be entered into. All entries will become the property of the RSGB. Please state on your entry if you do not wish to receive further promotional material or offers from the RSGB. The competition is open to current RSGB members only. Employees of the RSGB and of bhi are not eligible to enter.