

There are some instrumentation problems when using ham transceivers as "radar" sets. Transmit/receive switching may not be fast enough, and our newer rigs with digital signal processing may have unexpected properties in the time domain. In my experiments, I found that I had to characterize the delay properties of my Ten-Tec Orion receiver.⁸ The delay time of a signal from the antenna to audio output for CW or SSB and normal filter characteristics was about 14 ms. In his work, K4MOG used a Yaesu FT1000MP-MkV transceiver, which also has DSP filtering. His observation of excess delay compared to an earth circumference may be the result of receiver delay time. — 73, Martin Ewing, AA6E, 28 Wood Rd, Branford, CT 06405; aa6e@arrl.net

MAGNETOSPHERIC DUCTING AS AN EXPLANATION FOR DELAYED 3.5 MHz SIGNALS

◇ Gene Greneker, K4MOG, gave an interesting and well-documented account entitled "The Ultimate DX: An Around the Earth Path" in the Technical Correspondence column, in the June 2007 issue of *QST*. Over a 30 minute period he heard his own signal coming back on 3.524 MHz at a delay of 165 to 168 ms. He explained it as a signal traveling around the earth, possibly along some ionospheric duct, in order to account for the additional delay compared to the usual 138 ms. This is plausible not the least because of his good experience with DX with the antenna he was using. K4MOG has told me that the additional 27 to 30 ms compared to 138 ms also could be explained by the delay from the onset of the sidetone to the start of the transmission, as is evident from the *QST* Product Review of a similar transceiver having a delay from key-down of 20 ms (Figure 2 of the Yaesu FT-1000MP Product Review⁹).

As it is very rare that signals at such low frequencies travel around the world, I would like to offer an alternative explanation. Signals in the 160 m and 80 m bands can be trapped in occasionally occurring, tubular magnetospheric ducts, which stretch from the northern to the southern hemispheres along the Earth's magnetic-field lines. See Figure 1. K4MOG has been very helpful in providing additional data as well as giving me his recording of the echoes (available with his permission at www.qsl.net/de/la3za/prop/#MDE), and I have used this to try to support this explanation.

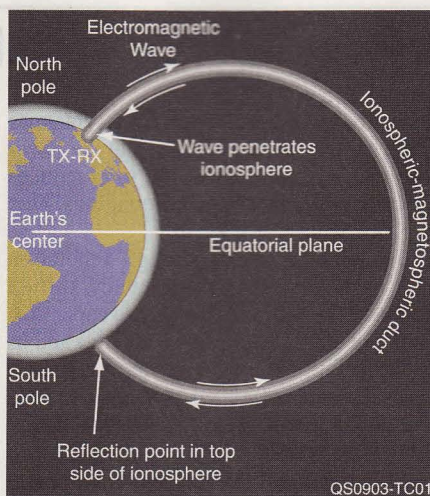


Figure 1 — This sketch shows a magnetospheric duct (with a delay of 0.27 seconds). (Copied from the Oct 1980 *QST* article referenced in Note 10.)

Due to its southern location, the expected delay at K4MOG's location in Georgia is only about 0.15 seconds (see Figure 4 of the Oct 1980 *QST* article by O. G. Villard, W6QYT and others¹⁰). The delay, however, depends on geomagnetic latitude — the latitude relative to the magnetic North pole. This position shifts with time, and in 2006 his location was at 44.8° North relative to the geomagnetic North pole (<http://modelweb.gsfc.nasa.gov/models/cgm/cgm.html>). This gives a delay of 143 ms, 9 ms less than in 1980 when that *QST* article was written. This is only 5 ms more than a typical around-the-world signal, making it quite hard to distinguish a ducted signal from one that has traveled around the earth.

The main reason to believe that these are not around-the-world echoes is the quality of the K4MOG signal. The amplitude of each echo is stable and the tone is pure, quite unlike signals that have passed around the earth. Although K4MOG found a slight decrease of frequency with time, they are still very much like the echoes plotted in the article listed in Note 11, which are characterized by "a low level of absorption" and "practically no dispersion or Doppler shift." K4MOG also observed an increase in delay time of 3 ms over 30 minutes, similar to the 260 ms delay described in the article listed in Note 12, which decreased by 10 ms over 67 minutes.

Other factors that point towards ducting, as described in the article of Note 10 are:

■ The best months from the northern hemisphere are December and January. Ducting in February and November is about half as common, and the rest of the year it is less likely. K4MOG received his echoes on February 17.

■ The best times are between 1900 and midnight local time. K4MOG received his echoes at 0345 UTC, or 2245 local time.

■ The antenna should radiate well in the direction of the magnetic field, as for instance a horizontal dipole oriented East-West would do. K4MOG used a 7 MHz double Zepp oriented North-South at a height of 70 feet (21 meters). Since it was used at half the design frequency, his antenna is probably nearly omnidirectional, as evidenced by his experience with DX both to Europe and to Antarctica. Its height of about $\frac{1}{4}\lambda$ should also ensure substantial radiation upwards.

Also, the likelihood for ducting increases near a solar minimum, as indeed 2006 was.¹³

Finally, the value for the critical frequency, f_{oF2} , at two nearby sites, Eglin Air Force Base in Florida and Dyess Air Force Base in Texas, show values as low as 3.1 and 2.8 MHz respectively at the time (<http://umlar.uml.edu/DIDBase/>), indicating that a vertical signal at 3.5 MHz could have passed through the ionosphere and thus entered a magnetospheric duct. — 73, Sverre Holm, LA3ZA, Dæliveien 1, NO-1383 Asker, Norway, la3za@nrnl.no

Sverre Holm has been interested in radio since his teenage years, but did not get a license until 2001. His main interests are kit-building, CW, DXing and unusual propagation. He is a professor of signal processing at the University of Oslo, Norway, working mainly in the field of ultrasound and sonar imaging systems. He is a Senior Member of the IEEE.

POWER TO THE PEOPLE WITH A DC DISTRIBUTION SYSTEM (SEP 2008 *QST*)

◇ I read the Sep 2008 *QST* article by Joel Hallas, W1ZR, on 12 V dc distribution for the 12 V dc ham shack. I suggest noting several caveats, which may avoid some future heartburn.

1) Sizing the wire from the central power supply — Remember, low voltage/high current = "IR losses." Calculating your voltage drop due to power connections may reveal

⁷E. Pocock, W3EP, "Backscatter over the Atlantic," *CQ*, Apr 2006.

⁸M. Ewing, AA6E, "TT Orion: Adventures in the Time Domain," <http://blog.aa6e.net/2006/07/tt-orion-adventures-in-time-domain.html>, Jul 2006.

⁹Product Review, FT-1000MP MF/HF Transceiver, *QST*, Apr 1996, pp 68-73.

¹⁰O. G. Villard, D. B. Muldrew, and F. W. Waxham, "The Magnetospheric Echo Box — A Type of Long-Delayed Echo Explained," *QST*, Oct 1980, pp 11-14.

¹¹D. V. Blagoveshchensky, K. A. Dobroselsky, O. A. Maltseva, "Guiding MF Waves from the Earth's Surface into Space," *Annales Geophysicae*, Vol 15, 1997, pp 246-248.

¹²G. T. Goldstone and G. R. A. Ellis, "Observations of 1.91 MHz Echoes from the Magnetic Conjugate Point After Propagation Through a Magneto-Ionic Duct," *Proc Astronom Soc Australia* (3), 1986, pp 333-335.

¹³G. R. A. Ellis and G. T. Goldstone, "The Probability of Observing Ducted Magnetospheric Echoes from the Ground," *J Geophys Res*, Vol 95, no A5, May 1990, pp 6587-6590.