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QST Issue: Jun 1998
Title: An HF Polarimeter
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Technical Correspondence

Edited by ***Paul Pagel, N1FB*** *• Associate Technical Editor*

AN HF POLARIMETER

By Eric P. Nichols, KL7AJ, PO Box 56235, North Pole, AK 99705, e-mail **enichols@gci.com**

◊ A lot of interesting things can happen to a radio wave between here and there (or more appropriately to this discussion, *there* and *here*). One of the more interesting, and useful things to know about an incoming radio signal—from a scientific standpoint—is the polarization of the wavefront. Several things can happen to a radio wave in transit to alter its polarization after it is launched from the transmitting antenna. In fact, about the only time the polarization remains completely unscathed is when the receive and transmit antennas are within line of sight and in a perfect vacuum. Most hams don't operate under such conditions.

Anytime a radio signal bounces off a conductive surface, its polarization changes, unless the surface is either perfectly parallel, or perfectly perpendicular to the incoming wavefront. Obliquely reflected waves undergo a degree of polarization rotation dependent on the wavelength, the conductivity (or more accurately the *dielectric constant*) of the reflective surface, the distance it travels through the surface, and the original relative polarization angle. Ionospheric reflections add one more ingredient to the mix—Faraday rotation—which is a complex function of the electron density and the magnetic field.

It should be fairly obvious that the polarization of any HF signal undergoing multiple hops will rarely bear any resemblance to the original polarization of the launched signal. Additionally, the actual polarization of a signal can change quite rapidly over time. For example, a rain shower over an intermediate location can cause the ground conductivity—and hence the dielectric constant of the earth at that point—to change quickly. Polarization over the "gray line" can be erratic as well, as the rapidly changing ionosphere recedes or advances. This can also manifest itself as extreme Doppler shift. At nightfall, I have measured the actual recession of the F layer at well over 700 meters per second over interior Alaska! (More on the Doppler ionosonde that I helped develop appears in *QEX*.)[1]

There is still much to be learned about the subject, and the simple gadget described here allows curious hams to observe these rapidly changing polarization effects.

Figure 1 is the block diagram of a polarimeter. The antennas are simply a pair of 10 meter crossed dipoles fed through identical baluns. The entire circuit is nothing more than a pair of matched D-C receivers fed in phase quadrature. None of the components are critical except for the quadrature hybrid device. Mini-Circuits Labs[2] makes a wideband quadrature phase splitter (2 to 8 MHz) in the $50 range. Phase splitters can be constructed from discrete components, but as any old-time aficionado who's used the phasing method of SSB generation will tell you, it's not a trivial task! Better to bite the bullet and pay the piper. In my personal version, the DBMs are also Mini-Circuits devices, but you *can* roll your own in this case. The LO can be any stable HF generator with a +7 dBm output. The preamps are optional in many cases. If you do choose to use RF preamps, you should use well-matched devices. I happened to come across a couple of Avantek[3] MMIC devices that work nicely, but it's definitely overkill.

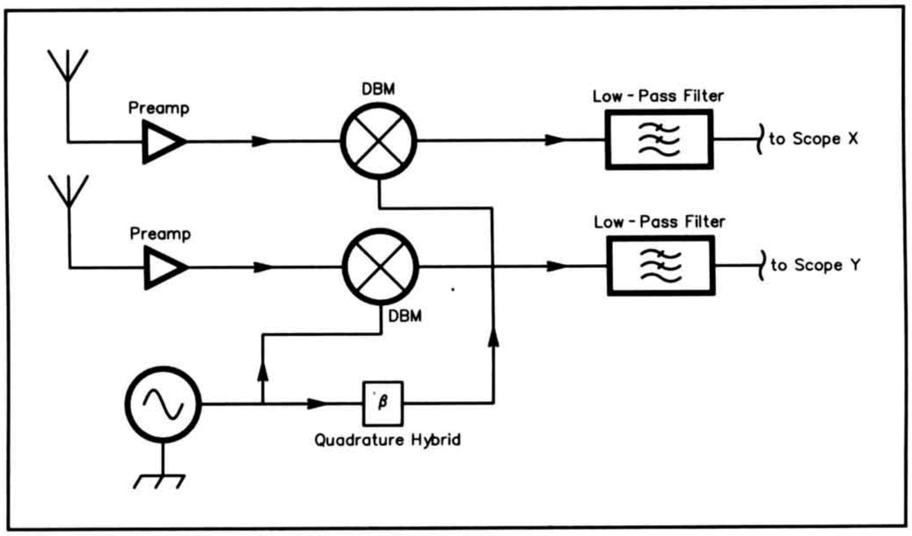

Figure 1—Block diagram of KL7AJ's polarimeter.

The real selectivity of the receivers—as with any D-C receiver—is achieved in the post-detection low-pass filters. I use three-pole Butterworth active filters, but here again, the response is not critical, except that the two channels be well matched.

Calibration is a simple matter: Disconnect the antennas, run a weak sample of the local oscillator into at **T** feeding both preamp inputs, (or DBM RF ports), feed the X and Y channels of the low-pass filters into the respective X and Y inputs of a cheap oscilloscope, and see that you have a reasonable facsimile of a circle on your CRT. Check to see that you have a pretty good circle across the entire 2 to 8 MHz range. Now, feed an RF signal into the terminals one at a time, and be sure your 'scope's horizontal input causes horizontal deflection of the trace and your vertical channel's okay. Reconnect the antennas to the proper inputs and you're ready to roll!

It's especially fascinating to watch shortwave broadcast stations in the 40 meter (okay, 39 meter) band. This seems to be the frequency range in which polarization rotation is most radical; plus, you have a lot of strong carriers to play with (naturally).

I can watch my polarimeter for hours (which probably means I need a life!). Anyway, it's a simple tool that can reveal a lot about this intriguing aspect of HF.

[1]Eric Nichols, KL7AJ, "How the Ionosphere Really Works," *QEX*, Mar/Apr 1998, pp 37-40.

[2]Mini-Circuits Labs, PO Box 350166, Brooklyn, NY 11235-0003; tel 718-934-4500, fax 718-332-4661. Distribution center 800-654-7949, 417-335-5935, fax 417-335-5945.

[3]Avantek was purchased by Hewlett-Packard in 1991. see **http://www.penstock.avnet.com/avantek.htm#about** for more information.—*Ed.*

UNWANTED EMISSIONS COMMENTS

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◊ In February *QST*'s WARC-97 report,[4] the section on page 33 titled Unwanted Emissions contains news of particular interest to technically minded amateurs. New rules on