INFERENTIAL FREQUENCY MEASUREMENT

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BY

HETERODYNE ANALYSIS

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(ed. note: although written by Glenn Hauser for NASWA, SPEEDX and NNRC, and despite being directed to the SWL, I believe that this article would be of value to the medium-level MW DXer who lacks the necessary equipment for making PFMs)

Don't let that title scare you: this article will describe the easy (or, at least, inexpensive) way to measure shortwave frequencies more exactly, without special equipment.

But first, let's answer the question why? At the present state of the art, just about everyone (except some major broadcasters, such as Radio Moscow and VOA) favors expressing frequencies to the nearest 5 kHz. This makes sense, as 5 kHz is the normal separation between SW channels (unfortunately).

Yet, many stations can be found off-frequency (that is, 'split' somewhere between the 5-kHz clusters)—and on bands below 6 MHz, the 5-kHz spacing does not always apply. Some off-frequency operations are temporary, and/or vary widely; others are rock steady. Both are of interest to DXers: one is a symptom of poor engineering or transmitter malfunxion; the other can be as distinctive as a fingerprint, and a significant aid to identifying the station.

The best way to go about precision frequency measurement (PFM) is to employ a frequency counter (such as the Heath IB-1101 or IB-1102)[1]. With one of these, frequencies can be measured down to 1 Hz. A spectrum analyser[2] can also be very useful. But there is another method that can provide adequate results, is a bit of fun, and requires nothing more than a (preferably well-tuned) piano, or some other convenient wide-range musical instrument (or, if you are so fortunate, your own perfect sense of pitch).

You see, whenever two stations are not transmitting on the same frequency, there is a heterodyne between. Now, we can make some use of these annoyances! We can do this up to about 5000 Hz (5 kHz); some receivers attenuate audio frequencies higher than this, and the approximate limit of human hearing is 15 kHz.

Thus, it follows that if the exact frequency of one of the stations is known (or can be reasonably assumed), then the exact frequency of other can be inferred by determining the musical pitch of the heterodyne produced between them.

How to be sure which one is 'off' frequency? Several ways. Your receiver may be calibrated sufficiently accurately (depending on how far off one of them is); experience is a good tool: has the VOA ever been known to vary more than a few Hz? No. Another one, often overlooked, is the absence or presence of subaudible heterodynes. Yes, SAH[3]. Unless the two stations are zero-beat (exactly on the same frequency), they will produce a SAH. These are easiest to measure when less than 10 Hz (lacking a spectrum analyser or frequency counter). Simply count the number of 'flutters', or S-meter dips, per minute, and divide by 60. This is easier to do on MW, where there is less short-term prpagational fading. If one of the SW stations is fading due to propagation, it will be difficult to determine the SAH. Also, if there is a third station, this this will complicate the picture, as there will be not two, but three SAHs—as each station interacts with each of the others.

If the frequency involved happens to lie right on a harmonic of your crystal calibrator, you can also look for a SAH (they are most obvious when two signals are of the same strength). Even without an S-meter, you can often hear the SAH (not the pitch, but the regular flutter) well enough to count it. Check your calibrator against WWV first to be sure it's set with 'SAH range' of other harmonics.

The point is: if one of the two (audibly) heterodying frequencies has a SAH on it, it is safe to assume that one is 'on' frequency. Why? the chances are remote that two drifters or variants will just happen to land within 10 or 15 Hz of each other.

The big step is disarmingly simple: find the note that most closely matches the heterodyne pitch, and consult the table (be sure you're on the right octave). Now you can report the frequency to two decimal places. To determine whether the 'het' station is high or low, invoke your receiver's maximum selectivity and tune back and forth. If you still can't tell, or there's a chance neither is 'on' channel, you can nevertheless report their separation.

Some DX editors may be understandably reluctant to publish such superficially useless information. The extra digits throw frequency column alignment. But the PFM can be given in the text, for the benefit of all who are interested.

Musical Notes & Corresponding Heterodyne Frequency[4]

A	0.110	0.22	0.44	0.88	1.76	3.52
B^b	0.117	0.23	0.47	0.93	1.86	3.73
B	0.123	0.25	0.49	0.99	1.98	3.95
C	0.131	0.26	0.52	1.05	2.09	4.19
C#	0.139	0.28	0.55	1.11	2.22	4.43
D	0.147	0.29	0.59	1.17	2.35	4.70
E^b	0.156	0.31	0.62	1.24	2.49	4.98
E	0.165	0.33	0.66	1.32	2.64	
F	0.175	0.35	0.70	1.40	2.79	
F#	0.185	0.37	0.74	1.48	2.96	
G	0.196	0.39	0.78	1.57	3.14	
G#	0.208	0.42	0.83	1.66	3.32	

Frequencies are in kHz; based on standard American pitch wherein A above middle C equals 440 Hz. Notes other than A are not precise, but rounded. The third digit in the first octave is for clarity, not precision

[1] See "Precision Frequency Measurement" by Ronald F. Schatz.

Also relevant is "The FMS-3 Frequency Marker Standard" reviewed by Robert L. Foxworth.

[2] For an exhaustive review of the Heath SB-620 Spectrum Analyser, by Foxworth.

[3] "Yes, SAH!" by the author, explains SAH's as applied to MW. Order reprint No. T7.

[4] adapted from "Whistle a Happy Het?" by Ronald F. Schatz, IRCA DX Worldwide column, DX Monitor, March 23, 1974.